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THE

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AN IMPORTANT POINT IN PATENT LAW.

AMONG the many interesting legal problems which arise for settlement in connection with patents, one of the most important, from a commercial point of view, is the effect which the relationship of master and servant has upon the title to a patent for an invention made by the servant. Many business firms appear to be ignorant of the law on this subject, and act upon the principle that any patent for an invention made by one of their servants in the course of his employment belongs as a right to the firm. It may be that the servant is equally ignorant of the law, and is content to accept the principle thus laid down by his employers, but we cannot expect to find this submissive spirit prevailing generally amongst workmen, and considerable friction may be avoided by attention to the principles of law laid down in the decisions in cases before the courts. This question has been discussed, or at least referred to, on previous occasions in the technical Press, but reference may with advantage be made to it again at this time, as an important decision on the point has very recently been given in the Chancery Division of the High Court of Justice. We deal with the circumstances of that case presently; but as the decision in it, if taken alone, might lead to misapprehension of the true state of the law, we first consider the general effect of some earlier cases.

Put shortly, the position may be explained in this way:—A patent for an invention can only be granted to the "true and first inventor" thereof, and therefore, if the person answering that description be the servant, he is legally entitled to the patent. If master and servant are joint-inventors, each being responsible for some of the parts which together make up the complete invention, then a patent will be issued to them in their joint names. The master cannot shut out the servant from participation, nor the servant the master. What, then, is to be said of the case—perhaps most common of all—in which the master suggests an idea to the workman and leaves him to work it out in practice, to construct a mechanism which will fulfil the object aimed at in the original idea? It is clear that the servant or workman in this case is entitled to profit by any patent granted for the invention, as to him is due the credit of having devised the apparatus which forms the subject of the patent. But is the master entitled to rank as joint inventor? The answer to this question is "No," if he has done no more than suggest the idea; for an idea merely expresses a principle, and a principle cannot be patented. The position is not changed by the fact that the workman's invention has been made entirely in the time of the master, as may be seen from the decision of the Law Officer (Sir Edward Clarke, then Solicitor-General) in the case of Heald's Patent (1891), from which we quote the following sentence:—

"I am not aware of any authority which lays down that the invention of a servant, even made in the employer's time, and with the use of the employer's materials, and at the expense of the employer, thereby becomes the property of the employer, so as to prevent the person employed from taking out a patent for it."

Other decisions to the same effect might be quoted, but this one is sufficient for our purpose. If, however, any reader wishes to inquire more fully into the subject, he should consider the case of Marshall and Naylor's Patent (1900), where the High Court revoked a patent taken out by the masters and granted one for the same invention to the servant, who had undoubtedly acted upon an idea suggested by his masters, but was held to be entitled to the invention.

We have now arrived at the general principle of law involved in the question under discussion, but that the position may be considerably altered by circumstances, is clearly shown in the most recent case, to which we referred at the outset. This is the case of the Worthington Pumping Engine Co. *v.* Moore (*Times* Law Reports, Vol. 19, 1902, p. 84), which is of importance to all employers, as it shows that the exact relationship existing between their servant and themselves may be made such that if the former should take out patents for inventions made by him in the course of his employment, he will be considered to hold them as a trustee for the firm. In this case the defendant had until recently been manager in England for the plaintiff company, an American corporation. In the agreement under which he held this post, there were no stipulations or covenants regarding inventions or original suggestions which might be made by him, but the correspondence produced in the case showed that the relationship between the American company and their English manager was, in the words of the judge, "of the closest and most confidential character."

I think, says Mr. Justice Byrne, it is beyond question that it was part of defendant's duty to communicate and consult with the head office about any modifications and alterations in construction required to suit the demand of customers, and to offer such suggestions as might occur to him as advantageous to the plaintiff corporation in relation to the business he controlled. I think that he would not have been acting in accordance with the good faith implied in his contract had he kept back new ideas or details of construction suggested or carried out in ordinary course of business between the parties (even though such ideas or details might have been, in the hands of a third person, properly subject matter for a patent), with a view to his personal profit at the expense of the plaintiff corporation.

The defendant had been dismissed from the post of manager, and it was then discovered by the plaintiff company that he had at an earlier date taken out two patents in his own name for improvements which were afterwards incorporated by the plaintiffs in the pumps they sold to the public, and this action was brought to have it declared that he held these patents simply as a trustee for the company. The learned judge, in his decision, recognises the general principle of law which we have stated above, but he goes on to say that all the circumstances must be considered in each case, and in this case it would be inconsistent with the obligations to be implied under the defendant's contract of service to consider him entitled to the ownership of these patents. The position is thus expressed by the learned Judge:—

Having regard to the nature and scope of the defendant's employment, to the obligations and duties arising from such employment, to the trust reposed in him, to his own conduct in endeavouring to establish a trade for his employers in the very articles he in the action brought by him against them—[a separate action]—sought to preclude them from using, I think I should be wrong in holding that he is entitled to continue to hold his patents as against the plaintiff corporation. . . . . The main issue is this: Can the defendant, or can he not, without breach of his obligation towards his late employers, insist upon retaining and enforcing against them the patents he has taken out? I think he cannot, either in whole or in part.

This decision is of great importance, as it shows that even in the absence of express covenants on the part of servants to assign any patents taken out by them, the conditions of their employment may be such as to impose an implied obligation upon them to hold such patents in trust for the employers. Taken alone, as we have already indicated, some of the statements quoted from this decision might lead to an erroneous impression being formed as to the general law on the subject, but with the explanation given the matter is clear. The principle of law is the same throughout, but the circumstances of a particular case may be such as to rebut the applicability of that principle, as in the case above. It will be interesting to see the result, if this case should go to the Court of Appeal. The point raised calls for final settlement. Mr. Justice Byrne has confined his attention to the rights of the patentee against his employers and *vice versâ*; but his decision must seriously affect any rights which the patentee, as such, would have to grant licenses to third parties. The peculiar facts of the case must be kept clearly in mind in reading the judgment, and if employers wish to obtain rights over any patents taken out by employés, it will be much safer to secure these by express agreements rather than by trusting to prove an implied obligation from the conditions of employment.

Faults on Trolley Standards.

As electrical tramways multiply and develop throughout the country, new problems are constantly arising, the creation of which could hardly be foreseen, even by the most cautious minds. In these cases experience alone can serve as a trustworthy guide, and thus it arises that changes in the methods adopted become from time to time inevitable. But when such changes are made, the necessity again arises of consulting the teachings of experience to ascertain whether these changes are justified by the results ensuing from their adoption. As a case in point we may cite the regulation of the Board of Trade which required that the trolley standard of double-deck cars should be efficiently connected with earth. It was pointed out to the Board, some time ago, that the effect of this regulation, in the event of failure of the insulation of the standard or trolley pole, was to put a dead short on the line, which was very difficult to locate, as all the cars on the same section as the faulty car were rendered helpless by the opening of the circuit breaker at the power station, and there was no indication that the fault was of the kind in question.

As the result of these representations, the Board relaxed the regulation, to permit of a continuous warning signal being substituted for the dead earth connection, and in many cases a lamp was inserted in series with the earth wire, so as at the same time to provide the desired signal and to prevent the undesirable short. Other methods were also devised, to which we referred in an article a few weeks ago, in which mechanical means of indicating faults were utilised. In the course of an interesting interview with Mr. Trotter, electrical adviser to the Board, we recently learnt

some facts derived from experience with the respective devices in question, which go to show that the lamp signal is not of sufficient reliability to effectually fulfil the desired object. Owing to the high resistance of the lamp, a slight leak fails to raise the filament to incandescence, or even to a red heat, so that the main purpose of the lamp is not carried out; but under these conditions it is quite possible for passengers to receive a shock from the standard, of sufficient intensity to at least frighten them, and to lead them to complain to the authorities. Mr. Trotter himself has actually experienced a shock of this nature, and cases have been reported of passengers also receiving shocks, in which the lamps had lighted up, but the conductor had failed to clear the deck. The present view of the Board of Trade is, therefore, that the lamp signal is ineffective, and that some means ought to be adopted by which the standard is connected to earth at all times through a low resistance—thus rendering a shock impossible. By combining the earthing device with a prominent signal, the attention of the conductor is at once attracted to the cause of the stoppage of the car; his duty is then to clear the upper deck, break the earth connection, and run the car to the depôt with its own motors. The use of lamps will not be vetoed; but this method of complying with the regulation will be discouraged in all new work.

A Movable Sub-station.

It is impossible to escape the obligation to instal an adequate amount of spare plant in a central station; but any method for reducing the same amount of duplication in each of the sub-stations feeding long stretches of line by means of rotary converters, should receive careful attention.

In 1898 Mr. Bion J. Arnold, in laying out the Chicago and Milwaukee Electric Railway, designed a sub-station in which the electrical equipment was not duplicated. In case of a breakdown of the single plant, it was proposed to run a special car equipped with the necessary switch gear, transformers, and converter to the spot, and to continue supply therefrom till the permanent plant was repaired. The sub-station was equipped with a battery of sufficient capacity to run the line while the car was being brought up and connected. As a matter of fact, the scheme was not put in practice on this line, but an actual car was built and equipped by the Union Traction Co., of Indiana, in 1901. Since then the Wilkesbarre and Hazelton Railway of Pennsylvania has taken advantage of this capital-saving device, and one of the cars is illustrated and described in the *Street Railway Review* for November. Except for the absence of platforms the external appearance of the car is almost indistinguishable from that of an ordinary passenger car, but the interior, of course, is bare. The roof is removable in one piece, to permit the heavy machinery to be lifted in by a crane, and it is strengthened specially for this service. Probably because of the additional weight and complication, the car is not motored. It is 36 ft. long and 9 ft. 6 in. wide, and is mounted on two equal wheeled trucks of a heavy type. When equipped as a sub-station the car contains a switch-board, three transformers, and one rotary converter, weighing in all 22½ tons. When stripped of machinery the car can be made useful for the carriage of freight, or for other purposes.

Many American systems contain lines running to pleasure parks in the country, on which traffic during the winter months is practically non-existent, but for which during the summer a considerable output is required. In the ordinary course these lines are fed from sub-stations, in which capital is lying idle during a large portion of the year. The portable sub-station just fits this case, as it can be used to supplement a permanent plant which is not much too big for the winter traffic, or to deal with the whole supply on lines which are closed during the winter. In any case the outlay on buildings, plant and maintenance, can be reduced. On a smaller scale this idea might be adopted in some parts of England where the summer and winter traffics are disproportionate. In order to save laying a large amount of copper which is useful for a few months only in the year, a small portable boosting plant might be used with advantage.

METHODS OF SPEED CONTROL FOR INDIVIDUAL MOTOR DRIVING.

The competition for electrical motor work is apparently so keen in America that—now that one motor is practically as good as another—new methods of control are constantly being devised by rival companies with the object of securing orders by promises of increased economy in running.

It is not a difficult matter to show on paper that one system may be more economical than another, by assuming the conditions under which the motors will run. Whether or no such conditions obtain in actual practice, or any economy really results, and if so, whether *le jeu vaut la chandelle*, are points which the motor manufacturer or contractor does not, perhaps, inquire into too closely.

A few weeks ago the multiple voltage method of control was described in our columns,* in which six different voltages are obtained from a special motor-generator; then, in addition to the ordinary rheostatic method of control, there is the Ward-Leonard booster system, in which the line voltage is increased or decreased by the voltage of an auxiliary generator which is connected in series or in opposition as desired; the Bullock transformer or "teaser" system, and others. Most of these systems were discussed in a paper read at a meeting of the Am.I.E.E., on November 21st, by R. T. E. Lozier, who advocates the multi-voltage method of control above referred to.

The Westinghouse Co. has now brought out a special three-wire system, which, it is claimed, combines the various advantages of all other methods with the extra advantage of increased efficiency.

It is somewhat curious to note that, as the last important Westinghouse development we described was the operation of direct-current motors by means of alternating current, the system now referred to embraces, among other things, the use of an alternating current from a continuous current dynamo. Of course, an alternating current is generated in any dynamo possessing a commutator, but it is only recently that any serious attempt has been made—except in small fan motors—to utilise this feature directly.

There is, moreover, nothing novel in using the two voltages of a three-wire system for obtaining a wide speed range in a single motor. A still wider range is obtainable by the use of a double-wound motor with two commutators on the two voltages, but the point of novelty in the new Westinghouse system lies in the method of producing two voltages from an ordinary single-wound generator. This is fully described in a paper read on the same occasion as Mr. Lozier's paper, by N. W. Storer.

The generator is wound for the maximum voltage required—say, 250—and, in addition to the commutator, four collector rings are mounted upon an extension of the shaft, connected to the armature windings, in the same way as would be done in a two-phase rotary converter. Each pair of collecting brushes is connected to a balancing coil; that is, there are two coils, each fed by one phase of the alternating current. The middle points in these coils are joined together, and to the neutral wire of the three-wire system, the outers being taken directly from the commutator brushes.

Such a machine may be operated in parallel with any existing three-wire system.

The author compares this system with the multi-voltage system, to the disadvantage of the latter as regards both efficiency and the amount of attention required. Whilst, he says, the multi-volt system requires two balancing wires, the three-wire system needs but one of smaller section, and the branch wires to the motors are also considerably lighter on the three-wire method.

On the other hand, it is proposed, on the Westinghouse system, to obtain 100 per cent. speed variation by field regulation; that is, it is intended to run up from half to full speed by weakening the shunt excitation. This involves motors of double the size that would be necessary if no shunt variation were used, with a correspondingly increased cost. As Mr. Lozier points out in his paper, 30 per cent. is

* "Notes on Recent American Installations," October 31st, p. 727.

about the maximum shunt variation that can be obtained from an ordinary standard motor run at its normal rating. This, Mr. Storer practically admits, and in the concrete example given a 10 H.P motor is used, although only 5 H.P. is required.

It is this extra cost of motors, wiring, switching arrangements, balancing coils, and addition to the dynamo, that causes us to query the ultimate economy of the system. It is from America that all these complicated, though ingenious, systems of speed control hail, and it would be interesting to learn whether they are invented for English consumption only, or whether they have any considerable application in the land of their birth.

In this country the same requirements as are met by the Westinghouse system would no doubt be considered to be satisfactorily fulfilled by a double-wound generator, or by the use of a small balancer, but it is questionable if there is really any very great need in ordinary practice for such speed variations as 1 to 6. From the two papers before us we gather that the two rival systems advocated—viz., the multi-voltage control and the special three-wire method—have been got out to meet the conditions of ordinary machine-shop practice, from which it would appear that the flexibility of electrical systems, and the more perfect speed control which the individual motor method gives, have created a demand for wider ranges of speed than were obtainable under the more rigid system of mechanical driving.

THE DESIGNING OF POLYPHASE CURRENT MACHINES.

By DAVID BERGMAN.

STANDARD types of direct current machines have nowadays reached a considerable degree of uniformity, but with regard to the designing of alternating current machines, many and various methods have been adopted. This article has been written for the purpose of distinguishing the most important features of these, and especially in order to draw a parallel between different practices in Europe and America.

The first three-phase induction motor made had a rather small power factor (0·6—0·7), and this, of course, showed its bad influence in many ways. It was very difficult to keep the supply voltage reasonably constant, and essentially much more copper was required for the conductors. On account of the unfortunate experience obtained with the first plant, the low power factor made a very bad impression on the public mind. Consequently, engineers had to design motors with a far better power factor, and, except in the case of very small motors, they soon succeeded in attaining a power factor = 0·85—0·9, while nowadays a power factor of 0·92 is no rarity. It was, however, not always the case that simultaneously due attention was paid to the efficiency.

There are many ways and means by which a high power factor is to be obtained, and some of them are as follows :—

To distribute the windings in a great number of slots.

To make the diameter of the armature large, and keep the length of core small.

To reduce the number of conductors and simultaneously keep the no-load current small.

These possibilities of increasing the power factor are not independent of each other; on the contrary, they are very closely connected. In spite of this, however, it is easy to distinguish how the one or the other possibility is utilised by different manufacturers and in different countries.

In order to get the no-load current as small as possible, the motors require closed slots, but this is very undesirable, as it increases considerably the cost of manufacturing. It was, of course, the desire of every designer to make the motors cheaply. Many of the principal American establishments, therefore, decided to use entirely open slots in order to get the motors cheaply manufactured, but in consequence of this the motors had to be built much larger in order to prevent the no-load current being too large; it cannot be denied that even by this arrangement a good power factor can be obtained. In Europe, however, the same result as to the power factor was obtained by making use of nearly closed slots, the manufacture then being more expensive, but on the other hand, the material costs were reduced. Besides, the Americans succeeded in getting their motors cheap by making use of the squirrel-cage type (for sizes up to 50 H.P.), but in Europe the polar-wound slip-ring motor was mostly employed.

What are now the results regarding the respective qualities of motors designed in these different ways? The power factor will have about the same value in both cases, but the efficiency will, of course, be much poorer in the case of the

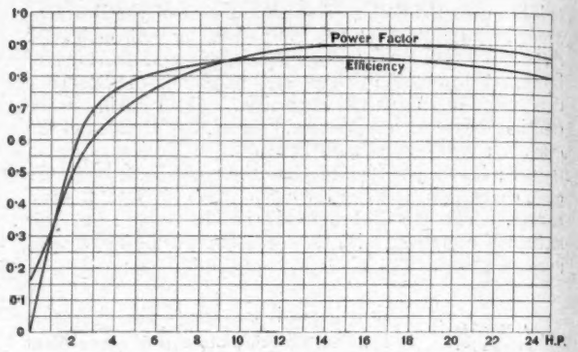


FIG. 1.—THREE-PHASE MOTOR FOR 15-H.P., 6 POLES, 50 PERIODS PER SECOND. NEARLY CLOSED SLOTS, POLAR-WOUND MOTOR, WITH SLIP RINGS.

American motor, not only on account of the larger sizes and the open slots, and the thereby increased constant losses, but also because the squirrel-cage type requires a greater slip. In order to illustrate the above, fig. 1 shows the efficiency and the power factor of a motor, designed with nearly-closed slots, and provided with slip-rings. In fig. 2 the

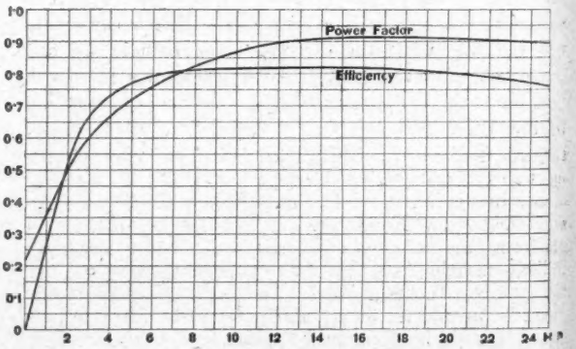


FIG. 2.—THREE-PHASE MOTOR FOR 15-H.P., 6 POLES, 60 PERIODS PER SECOND. ENTIRELY OPEN SLOTS, SQUIRREL-CAGE ROTOR.

corresponding curves are given for a well-known American motor of the squirrel-cage type, and for the same output as the former. The motor illustrated in fig. 1 is designed for 50 ~, and the American for 60 ~, but this will not make much difference. It will be seen from these curves that the power factor of the American motor is somewhat better, but the efficiency is about 4 per cent. poorer at normal load.

It would certainly be desirable to pay more attention to a good efficiency, and to ensure that the efficiency at least did not suffer through too strict conditions being stipulated for the power factor. A compromise between the efficiency and the power factor could be obtained if the product of these two were adopted as a measure of the general excellence of the motors. The curves given in fig. 3 show this product for the two motors, whose characteristic curves are given in figs. 1 and 2. It will be evident from the above curves that with regard to efficiency the American motor is inferior. However, it cannot be denied that the entirely open slots are sometimes preferable, for instance, in railway motors.

It is very desirable that the motors should have a high power factor in order to prevent the difference of phase in

the line being too considerable. However, it will not make much difference whether the power factor of the motor at normal load is 0·90 or 0·92, especially as a motor with a high power factor almost always has a poor efficiency.

It is, on the other hand, a matter of great importance to design the generators with a small drop of voltage, and this, of course, is still more the case if the power station has a small capacity. It is, indeed, possible to obtain a small drop of voltage by reducing the self-induction, but only to a certain extent, depending principally upon the dimensions, these being essentially much larger, and consequently the cost increasing. Besides, considering parallel working, it is desirable that the machine should have a certain amount of self-induction.

The drop of voltage in alternating-current generators is, however, dependent not only on the armature reaction directly, but also upon the increased leakage of the poles, as well as on the slots in the armature.

Consequently every designer aims to begin with designing the generators so that the leakage at all loads keeps practically constant, and further, to design the cores in such a way as to make it possible to diminish the injurious effect of increase of leakage on the drop of voltage due to the load of the machine. These conditions being fulfilled, a high degree

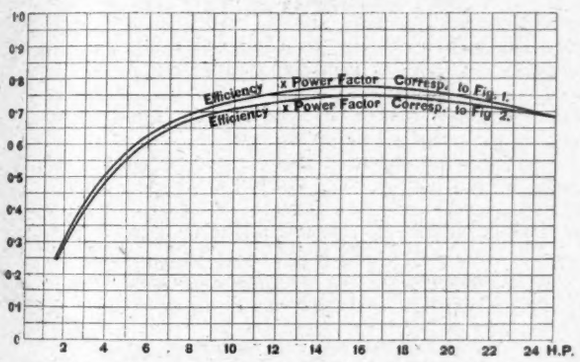


Fig. 3.—Curves showing the Product of Efficiency and Power Factor for the Motors whose Characteristic Curves are Illustrated in Figs. 1 and 2.

of saturation can also be maintained. Generators designed as prescribed will have a small drop of voltage, and besides, the costs of material will be considerably reduced.

The principles developed above are not difficult to realise with low-speed machines, but will be rather difficult with machines for a large number of revolutions per minute, if the inside-pole type is used.

Many of the principal American establishments, therefore, have decided upon the outside-pole type with rotating armature machines for 500 revolutions or above, this type being very favourable for other reasons also. The efficiency of these machines is essentially much better, and they are cheaper to manufacture.

It is indeed remarkable that this machine has been introduced into Europe only to a very small extent, in spite of its many advantages.

There may be some objections to the use of outside poles, as, for instance, the slip rings as well as the cross connections must be insulated for high voltages. These objections are, however, scarcely justified, as machines of these sizes are very seldom required for a higher voltage than 3,000 volts. The day may, however, not be far away when we in Europe also learn to appreciate the virtues this machine possesses.

STANDARDISING ENGINE TESTS.

The final report of the committee appointed to standardise engine tests, has been presented to the American Society of Mechanical Engineers, together with a report of the discussion. While this is a report that an engineer will be glad to have by him, it is one that few will carry out at all fully in practice, and in itself, together with the discussion, it is evidence of the difficulty which is inherent to the standardising of abstractions. Power plants must be standardised on exactly similar lines before they can be tested on the equal terms aimed at in this report, and as elevation above sea level, and the state of the barometer are such big factors, how are they to be allowed for in arriving at a correction? We find no fault with tests as such. They are necessary and desirable, but we do find fault with the way in which the results are set down in black and white, and no remarks are made to qualify such results as are obviously doubtful.

It is, of course, well known that when engine makers test engines in their own places, they often get results that are absolutely impossible, results, as one builder lately remarked, over 100 per cent. In such cases, no doubt, they search for errors until they bring down results to something under the fatal 100 per cent., and stick to it as a *record*. No matter how carefully a test may be carried out, the instrumental errors and observation errors will sometimes coincide and give incredible results, but it is certainly dangerous to set down such results without qualification. Many good points are made in the report, notably that tests should be started exactly when reliable observations all round can be secured, and not at an exact hour or minute. It seems to us the proper practice to set all watches to a distinct minute when the test starts. It is an easy matter to set a watch, and it appears to matter very little that correct solar or sidereal time is not kept so long as the duration of the test is accurately observed.

There is a reference to the duration of a complete test being 24 hours. It is impossible to lay down such a standard rule. Nor do we think much value attaches to the observing of fires at start and finish. Of course, the coal consumption at the end of the test should be known if possible, but the true running of an engine cannot be measured when the start and stop are taken in. If coal and water are supplied in small quantities at once, say, 50 or 100 lbs. of coal and 50 gallons of water, and as each lot is finished it is plotted on squared paper, it will be found that the two curves are very regular, that coal rapidly disappears during the first part of the run if the fire is started from a bare grate, and that at the finish the water curve still continues, while the coal curve runs horizontally during the burning-down of the fire to the starting level. The inclination of the two curves throughout a length of the middle part of the run will give better commercial results than any figures got by dodging the fire's record.

In stating the value of a fuel, its whole heat of combustion is taken on the basis of a final temperature of 0° C., that is to say, without deducting the heat of vaporisation of water formed from the hydrogen of the fuel, or hygroscopically included. For a practical people like the Americans, aiming at commercial standards, this is a little odd.

More curiously still, Mr. Kent, a well-known authority, approves of this method, and goes on to say that the latent heat of vaporisation of the steam in the flue gases may be made use of by an economiser "*when the water is very cold.*" The italics are ours. He is perfectly right in his statements, and every experienced steam engineer knows that when an economiser is worked below 90° or 100° F., the action claimed by Mr. Kent does occur; steam is condensed on the lower ends of the pipes, and the latent heat is so far saved. But all fuels contain some sulphur, and produce SO_3 when burned; this unites with the water to produce sulphuric acid, H_2SO_4, to the rapid destruction of the pipes of the economiser, and the blocking up of the scrapers, and general disaster. Surely Mr. Kent knows this, and yet he puts forward the cold economiser as the cure for wasted heat. He is entirely wrong so far as boiler practice goes, until a material is discovered out of which non-corrodible pipes can be made at a commercial price.

Reverting for the moment to Mr. Kent's endorsement of the method of total heat of combustion of hydrogen being taken, we cannot agree that the difficulties he names exists to the extent he would have us believe. There is no occasion when estimating the heat lost up the chimney to calculate

for the latent heat of the steam. This may be omitted altogether, and the heat carried off by the steam calculated from its specific heat of 0·479 exactly like any other so-called non-condensable gas.

A note by Mr. Christie refers to Joule's equivalent. He objects to the so-called latest determination of 778, which corresponds with raising $\frac{1}{778}$th of a pound of water from 32° to 212°—that is to say, to the $\frac{1}{778}$th of the amount of heat necessary to raise one pound from freezing to boiling point. This range is 100·5 units according to Regnault. For the old idea of measuring the equivalent at or near the freezing point, the 100 units would be 770 × 100, and not 778, nor yet Joule's figure of 772. No one knows exactly what the unit is, but it may be anything from 770 to 780 foot-pounds. Joule did not take the unit as the average of the liquid range, although, according to Mr. Christie, this was done in fixing on 778.

The Committee have had a difficult task, and have put a lot of hard work into it. The result has come in for good deal of criticism, and no one seems to be pleased.

TRAMWAY ACCOUNTS AND THE QUESTION OF DEPRECIATION.

The excellent treatise of Mr. Donald McColl,* the late chief book-keeper of the Glasgow Corporation, adds to the evidence of practical experts in support of the principle of proper provision for depreciation. So convincing are the opinions of Mr. McColl, that even our contemporary, the *Municipal Journal*, admits the cogency of his reasoning, although in fear and trembling, lest the result of such sound finance should be cited as a proof that municipal trading fails.

We have often had occasion to refer to the accountancy of the Corporation of Glasgow in connection with their electric lighting undertaking, the principle of providing for renewal and antiquation of plant out of revenue, apart from the sinking fund for repayment of loans, having always been recognised. It is not surprising, therefore, to find that the tramways accounts are dealt with in the same way, and we agree with our contemporary in admiring the large spirit in which Mr. McColl deals with the question.

Mr. McColl puts the case forcibly when he says that "depreciation should properly be provision for renewals only, corresponding to the shrinkage in value of the assets, and that ordinary repairs executed must, in addition, be charged year by year against revenue."

The most rapid depreciation in the equipment of a tramway is the permanent way, especially in a busy commercial centre like Glasgow, where the heavy traffic on the roads causes rapid deterioration. In a letter from the general manager, it is stated that revenue is charged with £450 per mile annually to meet the cost of renewals, the average life of the permanent way being calculated at 10 years. What a commentary upon the arguments of those who contend that by paying the original cost, by a sinking fund extending over 31 years, there is no necessity for any other provision for depreciation!

It is difficult to understand how anyone can dispute the position that in all undertakings such as electric tramways and electricity supply for light and power, revenue should be charged not only with the cost of maintenance, but with the depreciated value of buildings, plant and equipment, altogether apart from the repayment of loans constituting the original capital outlay.

As Mr. Young points out in his letter to Mr. Biggs (who indicated in his recent paper that the maintenance and depreciation charges together should equal the amount of the sinking fund) this is impossible where the renewal of the lines may be required three times over before the capital has been paid through the operation of the sinking fund.

The question of loss of value by *antiquation* may not be so important in the case of a tramway as in an electric supply undertaking, but it may have to be dealt with presently, when the fight for supremacy is over between the trolley, surface and conduit systems, as the principle must ultimately prevail of "survival of the fittest."

It is satisfactory to find that the Local Government Board is recommending caution to local authorities in their applications for loans. This is timely advice, and the ratepayers everywhere should "read, mark, learn and inwardly digest" it before rushing on with speculative schemes which will not mean lower rates, nor prove that the conclusions of the opponents of municipal trading in electric undertakings are misleading.

What can be more misleading than the following statements, published recently by one of our contemporaries, with reference to the town of Nelson, under the heading "Municipal Trading means Lower Rates?" The total rates appear to have gone up steadily, year by year, from 4s. 3d. in the £ in 1893 to 5s. 10d. in 1902, and this, in spite of an increase in the rateable value of the district from £72,434 in 1892 to £123,026—in 1902—so that a penny rate produces £512 12s. 4d. now, against £301 16s. 2d. in the former year. It is true that the General District and Borough rates are rather lower, viz., 2s. 10d. in 1902, against 3s. 5d. in 1893—but if the increased rateable value is taken into account, what is there to boast of? A profit is claimed from the electricity works, but these have always been carried on at a heavy loss, if depreciation in value of the plant is provided for.

Mr. McColl's book will be of special interest to all engaged in the details of managing electric tramway undertakings and to those who would relieve the tedium of ordinary business routine, by studying the principles of accountancy in rhyme—he gives a specimen copy of verses. How far this will commend itself to the prosaic man of figures, we will not say. Old Weller had a great contempt for poetry, even under the influence of cupid's darts:—"Poetry's unnatural; no man ever talked in poetry 'cept a beadle on boxin'-day, or Warren's blackin' or Rowland's oil, or some o' them low fellows; never you let yourself down to talk poetry my boy," but Mr. McColl is right when he says:—

> Your sinking fund pays what you borrow,
> But does not write down your assets,
> Depreciate, or to your sorrow,
> Renewals will add to your debts.

INSTITUTION OF ELECTRICAL ENGINEERS.

Manchester Section.

A meeting of this section was held on Tuesday, December 16th, Mr. E. W. Cowan presiding. Dr. E. W. Marchant read a paper on "Electrical Haulage on Canals," illustrating it largely by lantern slides which showed examples of existing canals and their electrical equipment.

Owing to the extensive but unused network of canals in this country electrical operation is now receiving consideration; a paper on this subject is therefore most welcome, and though, perhaps, more could have been made of both paper and discussion, yet it will be of service to those interested in the solution of this problem.

Canals were at the height of prosperity towards the end of the eighteenth century, when the only other system of transmission was by horse vehicle, and necessarily costly; the introduction of railways into the country in 1825, however, rapidly put canals into the background, and they began to decline.

The canals in England are sadly neglected, the railway companies, who own about one-third of the total mileage, not encouraging the traffic. Though steam tugs are sometimes used on canals, they are not general, the horse being usually employed to draw the barges along. It is thought by some that not only should electrical haulage on canals be commercially possible, but this would be a means of raising the value of the canal systems, as a method of transit.

Little or nothing has been done in England in this direction, but several attempts have been made on the

* "Tramway Book-keeping and Accounts," by Donald McColl; Gee & Co., Publishers, London.

Continent, notably on the Charleroi and Brussels Canal, the Finow Canal, and the Canal d'Aire et de la Deule; these are described in the paper. The author draws two main conclusions: first, that the most suitable method of haulage is by tractors running along the towpath; secondly, that the three-phase system is best adapted to the work.

In opening the discussion, Mr. Clirehugh said that though they were indebted to Dr. Marchant for his paper, he was disappointed with some of the author's conclusions. It was obvious that any system of carrying a tractor along the canal bank would be out of the question in England, owing to the narrow and very rough surfaces. He had seen some extraordinary devices used on canals to reduce the expenditure on upkeep. The banks of canals to carry tractors of, say, two tons would necessitate great cost for strengthening. One thing against the canals here was the large mileage owned by railway companies, who openly acknowledged that they would close them if they could. Electrical haulage, he thought, must resolve itself into either self-propelled barges or tugs. With the large power stations now being erected throughout the country, the mains from which would probably be laid, to a great extent, along the sides of the canals, there should be a great future for electrical haulage. The ordinary speed of a horse-towed barge is $1\frac{3}{4}$ miles per hour; he thought 4 miles per hour would be the maximum without undue wear and tear on the banks; and he saw no objection to the use of a propeller.

Dr. W. G. Rhodes wished the author had had experience with electrical haulage, as it was one thing to be told of a system, and another to speak from actual practice. He would rather see the boat running on wheels than being pulled through the water. The erection of overhead wires, as shown on the screen, would not be tolerated in England, though it might work all right on the Continent, nor was it practicable to use tractors, owing to the poor state of the canal banks. One disadvantage of the three-phase system was the necessity for three trolleys; one trolley was bad enough to keep on the wire, and the difficulty would be much greater with three of them. He considered that canals were obsolete, and only under unusual circumstances would it be advisable to apply electrical operation.

Mr. Thomas pointed out that if canals were converted into light railways, the mills, factories, &c., that take their water from them would have to be compensated. In England there are 19 principal canals of about 1,600 total mileage, having a capital expenditure of £32,000,000 and an annual tonnage of 26,000,000 tons. The expenditure is about £1,200,000 and the revenue £1,800,000, leaving a profit of £600,000; but he doubted if the actual profit would be so large as this.

The usual charge for towing is 0·5d. per ton-mile for the first 10 miles, 0·45d. for the second 10 miles, and rather under 0·25d. for all above this. The maximum wharfage charges are 1·5d. per ton. He agreed with other speakers, that the bad state of the banks made haulage by tractors impossible.

Mr. Gunton was of the opinion that the tug would have to be resorted to for the practical solution of the question. In England the difficulties of overhead construction would be very great, owing to the large number of low bridges; also there would be difficulties through the barges passing each other. Mr. Stephenson asked if the cheap working of canals could not be facilitated by adopting electrical methods for loading and unloading the barges; also for working the locks. Owing to its greater flexibility, he, too, thought that haulage by tugs would be the most practical method, and that the lower efficiency would only be a secondary consideration. The depreciation of tractors appeared to be very high, would not that of tugs be less? One third of the total mileage of canals was owned by the railway companies. Taking the figures for one year, he found a falling off of 2,000,000 tons in the returns for railway companies' canals, and for the same year an increase of 5,000,000 tons in the returns for canal companies.

Mr. Ritchie pointed out that the canals on the Continent, where they often run for many miles through open country with few bridges and locks, are very different to those in England. The barges there, too, are much larger, and he failed to see that it would pay to have men driving tractors for the small boats in use here. If electrical haulage was a success, why had there not been more rapid extension? The very narrow tow-path would be against tractors in this country.

Mr. Frith asked if accumulators had been tried for this purpose? The efficiency of the tugs was very low; he suggested that they should first be tried, and if the traffic increased sufficiently, the canal banks could be strengthened and tractors used.

Mr. C. Cormack said that, as the advantage of canals was gained by water, he saw no reason why they should not use an electric fish; that is, he would reduce the dimensions of the tugs so as to be just large enough to hold the electrical equipment, and control it from the barge. Our canals, which ought to be used to greater advantage, had been very much neglected.

Referring to the paper, and in reply to the discussion, Dr. Marchant said the Board of Trade would probably not allow an overhead construction in England similar to that described. Repairs were rather frequent, and trouble had been experienced from falling trees. The use of the tow-path for tractors would depend on the cost of establishment. He realised there were great difficulties in the overhead construction. He could not say if electricity had been used for operating locks, and loading or unloading barges, but he believed it had been used for pumping. He was disappointed that nothing had been said in the discussion about the advantages of lighting the canal, thus making night operation possible; he thought there was something to be said for it. There was no necessity for a special man, with tractors; in Belgium they employed an ordinary driver for this purpose.

Since 1898, the mileage of electrical haulage on one of the canals referred to had been doubled. He was unable to say if accumulators had been tried, but he thought their rapid depreciation would be against them.

At the conclusion of the discussion a hearty vote of thanks was recorded to Dr. Marchant for his paper.

THE AUTOMOBILE RAILWAY SYSTEM.

What is there in the automobile railway system, that the *Times* of December 12th should make so great a song of it, informing us that on June 18th next, at 8.50 a.m.—mark the precision of day and hour—a train of automobile carriages will start from the Gare de Lyon, in Paris, and run to Dijon by noon—a distance of 315 km., or at a speed of 100 km. per hour? The *Times* correspondent writes of the affair exactly as though the whole principle of mechanical railway locomotion were new.

It appears, after all, to be merely an application of the Gardner and Serpollet tramway car, and it is certainly not a revolutionary means of carrying passengers. We have heard of revolutions in motive power before to-day.

According to the description, the least possible quantity of petroleum and the smallest possible quantity of water are to do the trick. "Possible" is good—it may mean so much, and conveys so little truth, but these quantities, which the unwary might be led into thinking were mere traces of oil and damp, are to produce the greatest propelling power—more superlatives, be it noted; the extremely powerful vapour is to act directly on the wheels of the automobile. It is a pity the word automobile was ever invented, it is, like that blessed word Mesopotamia, good to conjure by.

A further nonsensical piece of wordiness tells us that there is a surface condenser, whence the steam emerges as hot water to serve again. The weight of the apparatus is trivial, and so on, until we reach the final catastrophe of technical description, and learn that the automobile beast is pointed in front and isn't blunt behind, so that the atmosphere "thus becomes an auxiliary rather than an obstacle." Really, we can pass all but this last, which is only relieved by the statement that the invention will at first be confined to *trains de luxe*.

We wonder what the *Times* has done with its engineering editor. Its hysterical correspondent very innocently "believes he has said enough to demonstrate the pleasure which the system will afford travellers." We assure him he has—too much, in fact. For downright humour, and that unconscious, this precious description of a new adaptation of an old system to steam traction is very fine. Only engineers can appreciate the excruciating funniness of the affair, but we had scarcely thought it possible that even a layman could be so unsophisticated.

The North-Eastern Railway is credited with being about to run a petrol car between the Hartlepools, in order to compete with the electric tramways. To be serious, however, there is nothing much to say about the system. People who think they can drive a car at a speed of 100 km. per hour with insignificant motive power, are imagining too much from the scanty steam details of a Serpollet slow-running tramcar; whatever the traction per ton, the steam will be needed as now—in great volume. These ideas of the layman that a sudden reduction of fuel and water can be effected in steam engineering are, of course, quite erroneous.

The system of automobile cars for main lines is not one that commends itself. The place for the system is the short branch line, which now runs a very few trains per day, in place of keeping a single automobile car to run to and fro, and pick up passengers who can now walk the distance between trains. The Quainton and Brill branch would better form a trial line for the new system than the Paris—Dijon. Speeds of 16 miles per hour would prove better than 60. Steam power cannot be put into a car for high-speed work with ease, and such tentative experiments should be made under moderate difficulties; if found feasible, the system could then be developed on sound lines.

THE PHOTOMETRY OF ELECTRIC LAMPS.

The discussion on Prof. Fleming's paper with this title occupied two evenings at the Institution of Electrical Engineers, and served to illustrate the divergences of opinion that exist. The first point which occupied many speakers was "what should be measured?"; the second, "how should it be measured?"; and the third, "what should it be called?" As the author put it in his reply, are the things measured the things we ought to measure? Illumination is desired in order to enable us to see; the test of illumination is to take a newspaper, and ascertain if it can be read with comfort. Questions of vision are subsidiary. We would add, however, that with respect to street lighting this is the very thing the committee-man will not do. He gazes straight at an arc or a Nernst lamp and tries to gauge its brilliancy by the naked eye. Vain the attempt to make him turn his back on the lamp at a fixed distance and read some printed matter, and then repeat the experiment with another lamp as a mode of comparison!

The comparison of variously coloured lights aroused some feeling. The author indicated that, owing to the Purkinje effect, the eye could not discriminate brightness separately from colour; he went further, and described "discrimination" photometers. Sir William Abney went so far as to say he almost preferred to have colour differences in the lights to be measured, and Prof. Ayrton denied the effect attributed to the Purkinje experiment, and quoted experiments (or would have quoted them had Mr. Swinburne been more lenient) to prove that light was light and colour was colour. But the author stated the case clearly: to read, to view objects, and to enable one to "do something," in what would otherwise be darkness, is the object of illumination. Whether a red and green light could be compared to half of 1 per cent. is a small question. If one can see to read, the illumination is all right, if not, one is inclined to "say something appropriate." But for general purposes it would be desirable to be able to state the colour quality of light, to have some way of numerically stating the value of different illuminations, say, for distinguishing objects in a picture gallery. After all, Dr. Fleming hit the root of the matter when he said that a shopkeeper required a means of making objects as visible—or more visible, if possible—as by daylight.

Mr. Vernon Harcourt had not found any great difficulty in comparing flame lights and arc lamps by means of a Bunsen photometer, and gave an account of the South Foreland experiments. He emphasised the means taken—it was the degree of distinctness of the pattern of the star (in place of a grease spot on the photometer disc) that was observed; colour differences did not, then, distract the observer's attention. Dr. R. T. Glazebrook gave particulars of Mr. Petavel's experiments at the National Physical Laboratory on the Violle or solidifying-platinum standard of light.

Dr. Fleming's standard electric lamps came in for general commendation; the only criticism was that they were not a novelty. But Dr. J. T. Morris showed that it was not sufficient to assume that temperature could be neglected; by external heating of the space environing the lamp, he obtained the figures now given:—

Temperature ...	15° C.	52° C.	62° C.	27° C.	15° C.
Candle-power ...	16·00	16·65	16·78	16·24	15·96

The pentane lamp of 10 C.P. was considered to be the most satisfactory working standard. It did not require a glass chimney, and provided the pentane was pure, could be relied upon, although several speakers attributed any discordance to varying percentages of CO_2 in the air, and Mr. F. H. Varley was of opinion that moisture in the atmosphere would also exercise a considerable influence.

Mr. Trotter regarded the pentane lamp as an uncommonly good standard, so much so that the "standard candle-power" was becoming an arbitrary standard crystallised by the pentane lamp. The amyl acetate lamp was not favoured by speakers, and no one had a good word to say for the "Parliamentary standard candle." Prof. Ayrton quoted as an example of excellent work the report on electric lamps prepared for the Standard Oil Co. (U.S.A.). To show how difficult it was to rely upon photometric figures, he cited the tests of some lamps by four different observers, he himself being one, and an 8-C.P. lamp as an average gave 7·85 C.P. with 5·6 watts *inefficiency*. He referred to the arrangement for comparing the light at one angle of the crater of an arc lamp with the light taken at some other angle, and attributed it to Mr. F. W. Carter—who, we may add, fully described a discrimination photometer of his own invention in connection with it.* Mr. Patchell capped Prof. Ayrton's tests by giving some of his own: 100-volt lamps, average C.P. 12·76, average *inefficiency* 4·8 watts per C.P. for nominal 16-C.P. lamps; and for nominal 8-C.P., average C.P. 7·76, average *inefficiency* 4·24 watts per C.P.

The various forms of photometer were critically examined by various speakers. Some would have none of the variable sectorial angle type, others considered they worked admirably. Mr. Varley described an instrument of this class for comparing arc lamps with standard of low candle-power. Sir Wm. Abney strongly recommends the Rumford shadow method, the Bunsen or its modification, with a truly transparent "spot;" the Lummer-Brodhun seemed most in favour. Discrimination photometers were stigmatised as mere tests of the acuteness of vision. Mr. Trotter perhaps was most nearly in touch with the feelings of those in the audience who had spent weary hours at a photometric bench, when he objected to the Lummer-Brodhun instrument on account of its eyepiece, and stated that both eyes should be used, the observer stand some distance off, and *form a judgment*; all such work is of this nature, and cannot be regarded as an empirical measurement.

The discussion for once was of less value than the paper. The matter collected and systematised by Dr. Fleming, is of the utmost value to those who may ever be called upon to measure illumination values. The discussion showed how very positive one can be about a thing one has done, and done with success oneself, and how unwise it is in matters relating to the senses to deny ability in others. The gist would seem to be that if one had to tackle photometric work with a free hand in the choice of instruments, the pentane lamp (with *pure* pentane), and a Lummer-Brodhun photometer would, after the observer had educated his discriminating judgment for colour differences, give results worthy of credence. But to attain anything like reasonable accuracy,

* Electrical Review, July 13th, 20th, 27th and August 3rd, 1900.

all the *minutiæ* relating to barometric pressure, humidity, percentage of CO_2, &c., incidentally referred to by the speakers would have to receive attention, and no better guide could be desired than Dr. Fleming's paper coupled with the full official account of the discussion upon it.

CORRESPONDENCE.

Single-Phase Electric Railways.

I notice in their letter to you dated December 9th, upon the above subject, that Messrs. Geipel & Lange make some incorrect statements with regard to the hydraulic variable speed gear invented by me, and referred to by Mr. Swinburne in his recent Presidential address to the Institution of Electrical Engineers.

What special qualifications Messrs. Geipel & Lange (as electrical engineers and agents in this country for the Ward-Leonard system) have for judging the merits of my hydraulic speed gear I do not know, but at all events it is necessary for me to correct them on two points.

1. They do not know anything about my hydraulic gear, since they have never seen the apparatus, nor had any opportunity of examining or testing it, whereas Mr. Swinburne has studied it, and thought it worthy of the special reference which he made to it in his address.

2. Their statement that hydraulic speed-reducing gears have been tried for motor cars, but without success, does not apply to my gear, which has fully demonstrated its capabilities as applied to experimental cars, and other cars fitted with it, are now in process of manufacture.

The gear is particularly applicable, and was described by Mr. Swinburne in special reference to "such large powers as are used for electric railways."

Messrs. Geipel & Lange appear to think it strange that the President "did not direct the attention of the electrical profession to the work done by Ward-Leonard and others in providing means of varying the speed electrically." Perhaps the reason for this omission was that Mr. Swinburne has satisfied himself that my hydraulic gear is suitable and highly efficient, and is, like myself, entirely in the dark as to any practical work that has been carried out on the system advocated by Messrs. Geipel & Lange.

I have entirely failed to find in the President's address the statement that, as alleged by Messrs. Geipel & Lange, "he was prophesying not what ought to be done, but what ought not to be done," but I do find the following (referring to another invention) :—"There seems to be great prejudice to it, because it is novel. When people, especially English people, strongly condemn a new thing without giving specific reasons, it is safe to conclude that it is very good."

As I see that Messrs. Geipel & Lange have been scattering their letter broadcast in the pages of the electrical and mechanical papers, I appeal to your sense of fairness to insert this reply.

J. W. Hall.

A Painful Experience.

Some short time back you gave prominence in your valued paper to the subject of consulting engineers. With your permission may I express in as few words as possible a recent (and, I am pleased to say, only) experience of mine of the kind, but one which all consulting engineers (except the one under consideration) would acknowledge to be an insult to their splendid profession. In the first week of November, 1901, I received a letter from a consulting engineer in Manchester asking me to call at his office and see him. I promised to do so immediately. I live some 20 odd miles on the south side of London, and, in order to keep my word, I slept in London overnight. I reached his office five minutes before appointment, and was informed by the office boy in charge that Mr. —— had gone to —— (a place some distance out of Manchester), would I follow? I did. After walking through wind and rain, and nearly breaking my neck, I found him. He engaged me for a certain berth, and told me I should be required in about two weeks. It was late by the time I returned to Manchester, which necessitated sleeping there the night. I returned south the next morning, gave up my rooms, and sent my furniture to my home. I waited three weeks and wrote for information: could give me no date as to when I should be required. After this waiting I sought other employment. The berth, I heard, was finally given to another person in September, 1902, or 10 months after I was engaged. I now ask for one week's salary and expenses, and am refused even a penny. I may add that some time after my first journey I advised this same man that I should again call upon him, giving him four days' notice. On arrival in Manchester I was told he was in London, and directly I got back to London he wired me he was going north at once, but would write. Needless to say he did not. I must admit that no arrangement was made *re* expenses, nor should I have asked for them had my appointment been kept. I think you will admit that this was unbusiness like and ungentlemanly conduct on the part of a so-called consulting engineer; or perhaps in this case "Mr. Dooley" is right. I believe this same "insulting" engineer has, or did have, on his brass plate, "sanitary engineer"—"sanitary" is good.

Disgusted.

Dry Car Seats.

Might I ask, through the Review, if any makers or patentees of electrical car seats will send me particulars of their appliances for keeping same dry in wet weather?

Herbert Lowe.

10, Lancaster Road,
Fallowfield, Manchester.

LEGAL.

Withers v. Gainsborough.

In Westminster County Court on Wednesday last week, before his Honour Judge Lush-Wilson, the case of Withers *v.* Gainsborough was heard. It was a claim brought by plaintiff, E. E. Withers, 217, Shaftesbury Avenue, electrician, against E. Gainsborough, 25, Hanover Square, Court milliner, for £14 and £3 respectively for extra work done, as electrical engineers. During March and April, this year, plaintiff did work for defendant at 25, Hanover Square, and when that was done, according to plaintiff's case, he was instructed by Mr. Gainsborough to do some extra work, which involved expenditure of £17. No complaint whatever was made by defendant until the work was completed, and an application was made to the architect for his certificate. All the orders relating to the first and second work were given to plaintiff's foreman. Defendant denied that he had ever given instructions for the extra work. He had never received the letter put in by plaintiff, in which defendant asked for eight extra points for lighting purposes in addition to those which had already been done.—Judgment was given for plaintiff with costs.

Smith v. The City of London Electric Lighting Co.

This case came before Mr. Justice Grantham and a special jury in the King's Bench Division on Tuesday and Wednesday last week. An action brought by the plaintiff against defendants for non-delivery of certain lamps to him by the defendants under a verbal contract.

Mr. McCall, K.C., in opening the case, said that the plaintiff was a dealer in electric fittings and electric lamps, carrying on business in East Ham, the defendants being a well-known company. In November, 1901, the defendants issued an advertisement in a paper call the *Electrical Engineer*, to the effect that the defendants had a large quantity of plant, material and stock for sale—included in that was a large quantity of 100-volt lamps, fittings, &c. The plaintiff, requiring lamps of this kind for the purposes of his business, applied in pursuance of the advertisement in the form of the tender mentioned in the advertisement, on December 9th. Before he sent in his tender, however, so as make sure that the quantity of lamps which the defendants had to sell were the quantities with which he could deal in his business, he went to the defendants' premises and saw a Mr. Rowlands, one of the managers, and a Mr. Talbot, a subordinate, and inquired from them the quantity of lamps they had, telling them that it was essential for him to have this information before he tendered. Mr. Rowlands and Mr. Talbot told him, after they had consulted the stock sheets, that they had 28,000 new lamps for sale, and that plaintiff could inspect samples. This the plaintiff did, and having regard to the statement made to him by Rowlands and Talbot, plaintiff in his tender, offered £300 for the lot of lamps. On Decem-

We wonder what the *Times* has done with its engineering editor. Its hysterical correspondent very innocently "believes he has said enough to demonstrate the pleasure which the system will afford travellers." We assure him he has—too much, in fact. For downright humour, and that unconscious, this precious description of a new adaptation of an old system to steam traction is very fine. Only engineers can appreciate the excruciating funniness of the affair, but we had scarcely thought it possible that even a layman could be so unsophisticated.

The North-Eastern Railway is credited with being about to run a petrol car between the Hartlepools, in order to compete with the electric tramways. To be serious, however, there is nothing much to say about the system. People who think they can drive a car at a speed of 100 km. per hour with insignificant motive power, are imagining too much from the scanty steam details of a Serpollet slow-running tramcar; whatever the traction per ton, the steam will be needed as now—in great volume. These ideas of the layman that a sudden reduction of fuel and water can be effected in steam engineering are, of course, quite erroneous.

The system of automobile cars for main lines is not one that commends itself. The place for the system is the short branch line, which now runs a very few trains per day, in place of keeping a single automobile car to run to and fro, and pick up passengers who can now walk the distance between trains. The Quainton and Brill branch would better form a trial line for the new system than the Paris—Dijon. Speeds of 16 miles per hour would prove better than 60. Steam power cannot be put into a car for high-speed work with ease, and such tentative experiments should be made under moderate difficulties; if found feasible, the system could then be developed on sound lines.

THE PHOTOMETRY OF ELECTRIC LAMPS.

The discussion on Prof. Fleming's paper with this title occupied two evenings at the Institution of Electrical Engineers, and served to illustrate the divergences of opinion that exist. The first point which occupied many speakers was "what should be measured?"; the second, "how should it be measured?"; and the third, "what should it be called?" As the author put it in his reply, are the things measured the things we ought to measure? Illumination is desired in order to enable us to see; the test of illumination is to take a newspaper, and ascertain if it can be read with comfort. Questions of vision are subsidiary. We would add, however, that with respect to street lighting this is the very thing the committee-man will not do. He gazes straight at an arc or a Nernst lamp and tries to gauge its brilliancy by the naked eye. Vain the attempt to make him turn his back on the lamp at a fixed distance and read some printed matter, and then repeat the experiment with another lamp as a mode of comparison!

The comparison of variously coloured lights aroused some feeling. The author indicated that, owing to the Purkinje effect, the eye could not discriminate brightness separately from colour; he went further, and described "discrimination" photometers. Sir William Abney went so far as to say he almost preferred to have colour differences in the lights to be measured, and Prof. Ayrton denied the effect attributed to the Purkinje experiment, and quoted experiments (or would have quoted them had Mr. Swinburne been more lenient) to prove that light was light and colour was colour. But the author stated the case clearly: to read, to view objects, and to enable one to "do something," in what would otherwise be darkness, is the object of illumination. Whether a red and green light could be compared to half of 1 per cent. is a small question. If one can see to read, the illumination is all right, if not, one is inclined to "say something appropriate." But for general purposes it would be desirable to be able to state the colour quality of light, to have some way of numerically stating the value of different illuminations, say, for distinguishing objects in a picture gallery. After all, Dr. Fleming hit the root of the matter when he said that a shopkeeper required a means of making objects as visible—or more visible, if possible—as by daylight.

Mr. Vernon Harcourt had not found any great difficulty in comparing flame lights and arc lamps by means of a Bunsen photometer, and gave an account of the South Foreland experiments. He emphasised the means taken—it was the degree of distinctness of the pattern of the star (in place of a grease spot on the photometer disc) that was observed; colour differences did not, then, distract the observer's attention. Dr. R. T. Glazebrook gave particulars of Mr. Petavel's experiments at the National Physical Laboratory on the Violle or solidifying-platinum standard of light.

Dr. Fleming's standard electric lamps came in for general commendation; the only criticism was that they were not a novelty. But Dr. J. T. Morris showed that it was not sufficient to assume that temperature could be neglected; by external heating of the space environing the lamp, he obtained the figures now given:—

Temperature ...	15° C.	52° C.	62° C.	27° C.	15° C.
Candle-power ...	16·00	16·65	16·78	16·24	15·96

The pentane lamp of 10 C.P. was considered to be the most satisfactory working standard. It did not require a glass chimney, and provided the pentane was pure, could be relied upon, although several speakers attributed any discordance to varying percentages of CO_2 in the air, and Mr. F. H. Varley was of opinion that moisture in the atmosphere would also exercise a considerable influence.

Mr. Trotter regarded the pentane lamp as an uncommonly good standard, so much so that the "standard candle-power" was becoming an arbitrary standard crystallised by the pentane lamp. The amyl acetate lamp was not favoured by speakers, and no one had a good word to say for the "Parliamentary standard candle." Prof. Ayrton quoted as an example of excellent work the report on electric lamps prepared for the Standard Oil Co. (U.S.A.). To show how difficult it was to rely upon photometric figures, he cited the tests of some lamps by four different observers, he himself being one, and an 8-C.P. lamp as an average gave 7·85 C.P. with 5·6 watts *inefficiency*. He referred to the arrangement for comparing the light at one angle of the crater of an arc lamp with the light taken at some other angle, and attributed it to Mr. F. W. Carter—who, we may add, fully described a discrimination photometer of his own invention in connection with it.* Mr. Patchell capped Prof. Ayrton's tests by giving some of his own: 100-volt lamps, average C.P. 12·76, average *inefficiency* 4·8 watts per C.P. for nominal 16-C.P. lamps; and for nominal 8-C.P., average C.P. 7·76, average *inefficiency* 4·24 watts per C.P.

The various forms of photometer were critically examined by various speakers. Some would have none of the variable sectorial angle type, others considered they worked admirably. Mr. Varley described an instrument of this class for comparing arc lamps with standard of low candle-power. Sir Wm. Abney strongly recommends the Rumford shadow method, the Bunsen or its modification, with a truly transparent "spot;" the Lummer-Brodhun seemed most in favour. Discrimination photometers were stigmatised as mere tests of the acuteness of vision. Mr. Trotter perhaps was most nearly in touch with the feelings of those in the audience who had spent weary hours at a photometric bench, when he objected to the Lummer-Brodhun instrument on account of its eyepiece, and stated that both eyes should be used, the observer stand some distance off, and *form a judgment*; all such work is of this nature, and cannot be regarded as an empirical measurement.

The discussion for once was of less value than the paper. The matter collected and systematised by Dr. Fleming, is of the utmost value to those who may ever be called upon to measure illumination values. The discussion showed how very positive one can be about a thing one has done, and done with success oneself, and how unwise it is in matters relating to the senses to deny ability in others. The gist would seem to be that if one had to tackle photometric work with a free hand in the choice of instruments, the pentane lamp (with *pure* pentane), and a Lummer-Brodhun photometer would, after the observer had educated his discriminating judgment for colour differences, give results worthy of credence. But to attain anything like reasonable accuracy,

* Electrical Review, July 13th, 20th, 27th and August 3rd, 1900.

all the *minutiæ* relating to barometric pressure, humidity, percentage of CO_2, &c., incidentally referred to by the speakers would have to receive attention, and no better guide could be desired than Dr. Fleming's paper coupled with the full official account of the discussion upon it.

CORRESPONDENCE.

Single-Phase Electric Railways.

I notice in their letter to you dated December 9th, upon the above subject, that Messrs. Geipel & Lange make some incorrect statements with regard to the hydraulic variable speed gear invented by me, and referred to by Mr. Swinburne in his recent Presidential address to the Institution of Electrical Engineers.

What special qualifications Messrs. Geipel & Lange (as electrical engineers and agents in this country for the Ward-Leonard system) have for judging the merits of my hydraulic speed gear I do not know, but at all events it is necessary for me to correct them on two points.

1. They do not know anything about my hydraulic gear, since they have never seen the apparatus, nor had any opportunity of examining or testing it, whereas Mr. Swinburne has studied it, and thought it worthy of the special reference which he made to it in his address.

2. Their statement that hydraulic speed-reducing gears have been tried for motor cars, but without success, does not apply to my gear, which has fully demonstrated its capabilities as applied to experimental cars, and other cars fitted with it, are now in process of manufacture.

The gear is particularly applicable, and was described by Mr. Swinburne in special reference to "such large powers as are used for electric railways."

Messrs. Geipel & Lange appear to think it strange that the President "did not direct the attention of the electrical profession to the work done by Ward-Leonard and others in providing means of varying the speed electrically." Perhaps the reason for this omission was that Mr. Swinburne has satisfied himself that my hydraulic gear is suitable and highly efficient, and is, like myself, entirely in the dark as to any practical work that has been carried out on the system advocated by Messrs. Geipel & Lange.

I have entirely failed to find in the President's address the statement that, as alleged by Messrs. Geipel & Lange, "he was prophesying not what ought to be done, but what ought not to be done," but I do find the following (referring to another invention) :—"There seems to be great prejudice to it, because it is novel. When people, especially English people, strongly condemn a new thing without giving specific reasons, it is safe to conclude that it is very good."

As I see that Messrs. Geipel & Lange have been scattering their letter broadcast in the pages of the electrical and mechanical papers, I appeal to your sense of fairness to insert this reply.

J. W. Hall.

A Painful Experience.

Some short time back you gave prominence in your valued paper to the subject of consulting engineers. With your permission may I express in as few words as possible a recent (and, I am pleased to say, only) experience of mine of the kind, but one which all consulting engineers (except the one under consideration) would acknowledge to be an insult to their splendid profession. In the first week of November, 1901, I received a letter from a consulting engineer in Manchester asking me to call at his office and see him. I promised to do so immediately. I live some 20 odd miles on the south side of London, and, in order to keep my word, I slept in London overnight. I reached his office five minutes before appointment, and was informed by the office boy in charge that Mr. —— had gone to —— (a place some distance out of Manchester), would I follow? I did. After walking through wind and rain, and nearly breaking my neck, I found him. He engaged me for a certain berth, and to'd me I should be required in about two weeks. It was late by the time I returned to Manchester, which necessitated sleeping there the night. I returned south the next morning, gave up my rooms, and sent my furniture to my home. I waited three weeks and wrote for information: could give me no date as to when I should be required. After this waiting I sought other employment. The berth, I heard, was finally given to another person in September, 1902, or 10 months after I was engaged. I now ask for one week's salary and expenses, and am refused even a penny. I may add that some time after my first journey I advised this same man that I should again call upon him, giving him four days' notice. On arrival in Manchester I was told he was in London, and directly I got back to London he wired me he was going north at once, but would write. Needless to say he did not. I must admit that no arrangement was made *re* expenses, nor should I have asked for them had my appointment been kept. I think you will admit that this was unbusiness like and ungentlemanly conduct on the part of a so-called consulting engineer; or perhaps in this case "Mr. Dooley" is right. I believe this same "insulting" engineer has, or did have, on his brass plate, "sanitary engineer"—"sanitary" is good.

Disgusted.

Dry Car Seats.

Might I ask, through the Review, if any makers or patentees of electrical car seats will send me particulars of their appliances for keeping same dry in wet weather?

Herbert Lowe.

10, Lancaster Road,
Fallowfield, Manchester.

LEGAL.

Withers v. Gainsborough.

In Westminster County Court on Wednesday last week, before his Honour Judge Lush-Wilson, the case of Withers *v.* Gainsborough was heard. It was a claim brought by plaintiff, E. E. Withers, 217, Shaftesbury Avenue, electrician, against E. Gainsborough, 25, Hanover Square, Court milliner, for £14 and £3 respectively for extra work done, as electrical engineers. During March and April, this year, plaintiff did work for defendant at 25, Hanover Square, and when that was done, according to plaintiff's case, he was instructed by Mr. Gainsborough to do some extra work, which involved expenditure of £17. No complaint whatever was made by defendant until the work was completed, and an application was made to the architect for his certificate. All the orders relating to the first and second work were given to plaintiff's foreman. Defendant denied that he had ever given instructions for the extra work. He had never received the letter put in by plaintiff, in which defendant asked for eight extra points for lighting purposes in addition to those which had already been done.—Judgment was given for plaintiff with costs.

Smith v. The City of London Electric Lighting Co.

This case came before Mr. Justice Grantham and a special jury in the King's Bench Division on Tuesday and Wednesday last week. An action brought by the plaintiff against defendants for non-delivery of certain lamps to him by the defendants under a verbal contract.

Mr. McCall, K.C., in opening the case, said that the plaintiff was a dealer in electric fittings and electric lamps, carrying on business in East Ham, the defendants being a well-known company. In November, 1901, the defendants issued an advertisement in a paper call the *Electrical Engineer*, to the effect that the defendants had a large quantity of plant, material and stock for sale—included in that was a large quantity of 100-volt lamps, fittings, &c. The plaintiff, requiring lamps of this kind for the purposes of his business, applied in pursuance of the advertisement in the form of the tender mentioned in the advertisement, on December 9th. Before he sent in his tender, however, so as make sure that the quantity of lamps which the defendants had to sell were the quantities with which he could deal in his business, he went to the defendants' premises and saw a Mr. Rowlands, one of the managers, and a Mr. Talbot, a subordinate, and inquired from them the quantity of lamps they had, telling them that it was essential for him to have this information before he tendered. Mr. Rowlands and Mr. Talbot told him, after they had consulted the stock sheets, that they had 28,000 new lamps for sale, and that plaintiff could inspect samples. This the plaintiff did, and having regard to the statement made to him by Rowlands and Talbot, plaintiff in his tender, offered £300 for the lot of lamps. On Decem-

ber 17th nothing had been done on the tender. Plaintiff called at the defendants' place of business, and he was then informed by Rowlands that the old list and the old tenders were off, and that there was a new list, dated December 9th, and that applications for the articles could be received up to December 16th, and that the list comprised a lot of about 25,000 new lamps. That day being the day after the date fixed for sending in the tenders, the plaintiff saw a Mr. Jackson, the defendants' chief engineer, on the matter. Jackson told him that the lamps which were in question in the case had been withdrawn—viz., new Ediswan lamps—but he asked plaintiff to make a verbal offer for the other lamps. Plaintiff had been told that there were 10,000 new lamps in addition to the Ediswan, and then the plaintiff offered £2 per thousand for them and 2d. apiece for the Ediswan lamps. On December 18th plaintiff again called at the defendants' place of business and saw Jackson and Rowlands, and at that interview terms were agreed on for all lamps except the Ediswan. The difficulty about these was that defendants wanted 3d. each for them. Plaintiff said that before making any offer at all for these he must be certain of the quantity, and he asked these gentlemen to refer to the stock sheets. Having done so, Mr. Jackson said that there were 17,697 at 3d. each. Plaintiff said he would like time to consider the matter, but at 4 o'clock the same afternoon he returned and accepted defendants' offer and thus concluded the contract. He, however, asked defendants to confirm this verbal sale in writing, and accordingly on December 19th the defendants wrote this letter to the plaintiffs:—"We beg to confirm the sale to you of our incandescent lamps at the following rates:—Ediswan new lamp, 3d. each, all other lamps £2 5s. per thousand, subject to cash and removal of the whole of the stock up to 57,000 lamps before the New Year." In the letter, in order to make the matter clear, defendants enclosed a copy of the stock sheets to which they had referred, and by those stock sheets it appeared that the contract referred to 20,129 Ediswan lamps, there being 68,000 pieces in the whole lot. The learned counsel submitted that it was clear that the contract was that defendants were selling to plaintiff 20,129 Ediswan lamps. What the plaintiff actually got delivery of was only 1,509, and then he was told by Jackson that a mistake had been made, and that the other Ediswan lamps could not be found, and that defendants could not deliver them. The plaintiff told Jackson that he had resold a large quantity of these lamps to his customers and they required delivery of them. The plaintiff never got delivery of the lamps, and accordingly he claimed from the defendants for the breach of contract £620 13s. 4d. that sum repr[illegible] the profit the plaintiff would have made if the lamps had been delivered by the defendants.

The plaintiff was called and gave evidence in support of his case.

On Wednesday the plaintiff was re-examined, and gave evidence as to the difference between the contract price and market price of the lamps.

In cross-examination by Mr. Walton, he said he quite understood that the City of London Electric Lighting Co. were not dealers in lamps.

And you understand that owing to changes in the character of the lamps supplied to their customers, they had in stock a large number of returned lamps and old material?—I supposed they had a new stock, but I don't know where it came from. I did not know the old stock came from their customers.

His Lordship said it would be difficult to get anybody to understand that whatever that contract was, it was not based on the original tender, which was not adhered to. There was a quantity of stuff, but no exact quantity, and he thought Mr. Jones would have great difficulty in convincing the jury that his client did not understand it was in that condition. He would find that both the documents on which he relied were ante-dated, and that it was stated that the company would not be responsible for quantities.

Mr. Lawson Walton (to plaintiff): Did you see at the head of the tender the words—"The purchaser will accept all responsibility for inspection, and must take the goods as he finds them, with all imperfections, and be responsible for his own quantities. The company do not guarantee the accuracy of the lists as to their description, number, or quality," and did you choose to tender for that large stock of material on that basis?—Yes.

And you had every opportunity of going to the warehouse and seeing what the nature and quality and extent of the stock was?—Yes.

His Lordship said that if the suggestion which had been made was true, the defendants must have been lunatics to sell 20,000 lamps for 2d. each for which they could have got 11d. in the market. When people tendered for things of this sort, they must take them as they were.

At this point a consultation took place between counsel, after which—

Mr. Lawson Walton said he was glad to say that they had settled the case. He might say on the part of the City of London Electric Lighting Co. that they had always been anxious to adjust the claim on what they considered a fair basis. There was, no doubt, that owing to the quantity in the warehouse, there was a mistake in the stock lists; but, at the same time, they never guaranteed the quantities, because the lamps had never been counted. They were in boxes and crates all over the place, and the quantities were constantly changing every day. There was an error common to both parties; but, if the company had been approached on a more reasonable basis, they would have been glad to meet the plaintiff. However, plaintiff was now more reasonable, and he would accept a sum which had been agreed on.

His Lordship said that it was very right that both parties should agree.

Judgment was then given for plaintiff for an amount agreed upon between counsel.

RESISTANCE OF ROAD VEHICLES TO TRACTION.

The report of the Committee of the B.A. on this subject, which was presented at Belfast, consists of 14 sections, the first 10 being a more or less historical summary of past records. Early last century Edgeworth found that at a speed of 8·8 kilometres per hour a vehicle with springs had a resistance of only one-third the resistance of one without springs, a proof that the resistance was largely due to lifting the weight of the vehicle at each little lump in the road, the work thus done being given back probably in damage to the road surface.

Coriolis, in 1835, advocated springs of maximum practicable flexibility and roads of maximum rigidity.

Morin, in 1837—1842, carried out many careful experiments, and deduced the following conclusions:—

1. That on fibrous materials, spongy textures, or granular bodies, resistance is inversely as the wheel diameter.
2. On compressible surfaces rolling resistance increases as tire width diminishes.
3. On elastic substances the depth of depression is proportional to weight, and the return of the surface is less rapid than its depression, and does not return the work done in compression.
4. On a homogeneous body as on wood, rolling resistance increases more rapidly as the pressure increases. Thus wood is unsuitable for heavy traffic.

Morin investigated the effects of weight, wheel diameter, tire breadth, velocity, angle of pull and efficiency of springs, and it is concluded from his first series of experiments, that:—

1. Resistance varies with the pressure, and inversely with wheel diameter.
2. Roads deteriorate inversely as the wheel diameter.
3. On macadam or paved roads, tire width hardly accounts, for tire breadths above 80 or 100 mm.
4. On loose or compressible roads traction decreases with tire width, but on hard roads it is not good to exceed 100 to 120 mm.
5. On soft ground resistance is independent of speed with or without springs.
6. At a walking pace on all roads, resistance is the same for all vehicles.
7. On macadam or paving, resistance increases with speed nearly in proportion to the increase with an initial speed of 1 m. per second. The better spring vehicles show up best.
8. Good sandstone pavement at walking pace has three-fourths the resistance of best macadam. At trotting pace it is the same, but with setts too wide apart the trotting resistance exceeds that on macadam.
9. The inclination of the line of draught for maximum efficiency increases with the road resistance, and as the fore-wheel diminishes. On the ordinary road it tends to the horizontal so far as vehicular construction permits.

After further experiments he found:—

Tires of 60 mm. were more destructive than those of 115 to 165, and about 115 is a maximum width. Morin also gave tables for wheel load and wheel diameters, which have been the basis of practice ever since, but Morin was strongly criticised by Dupuit, who arrived at very different conclusions, pointing out errors in calculations, and inferring therefrom errors in preliminary calculations.

He found on uniform surfaces, such as macadam, that:—

1. Resistance was as the load.
2. Independent of tire breadth.
3. Inversely as square root of wheel diameter.
4. Independent of velocity.

He found the mean tractive force to be 20 k. per 1,000 on paved and 30 on macadam roads, and only 6 on smooth flags and 10 on asphalt, and gave :: 1 : 4 : 6 as the resistance on rails, pavements and macadam respectively. He adopted 4,000 k. as the weight of a two-wheeled vehicle loaded.

Undulation was practically of no account.

Leahy, in 1847, found traction to vary as the velocity squared, and inversely as the square root of the cube of the wheel diameter. Generally he approved of Morin's deductions.

M. Charié-Marsaines, inspector of roads and bridges, found that, as compared with macadam, a paved road gives less wear on harness, more wear on vehicles, and less wear of horses.

Michelin more recently found the economy of pneumatic tires practically one-third over iron tires, but solid rubber tires were less efficient than iron except on good dry pavement; and his results generally corroborate Morin.

We look forward to the further report with interest.

IMPROPER MATERIALS.

"Cheap and nasty" is a term that has become ingrained into the English language, and we all know what it means.

There is a certain line of cost below which any further reduction must be done at the expense of quality. A good shop system of manufacture represents the minimum of cost in one direction; any economy beyond that point must come out of materials, and cheaper material usually means reduced excellence. It must not be understood that cheap material is necessarily bad. A steel cylinder is

better than a leaden one, and is also cheaper, but a cast-iron crane hook is certainly worse than a steel hook. Yet we are informed that such economies as making crane hooks that have not been forged out of the best possible material are practised by makers—not, we are thankful to say, in this country.

An economy has followed on competition in the motor-car industry which has, in a very curious manner, diverted the course of trade. At one time motor-car makers were accustomed to place orders for well-forged mild steel crankshafts, axles, forks, gear-wheel blanks, and similar parts. This trade has fallen off, so far as regards orders from the car makers. Yet the people who did the forgings are still getting the work, and are probably as busy as ever. Is it to be inferred that there is something mysterious in this? By no means.

The car makers are all in keen competition. One man supplies malleable cast-iron parts and effects an economy. Others have to follow suit, and cars are now built up with these shoddy makeshifts in their motors. Yet the forgemen remain busy and do not receive orders from the car makers. The explanation is simple. The orders now pour in from the car-repair shops. The work costs more, because it is now made in less quantity, fewer similar pieces at once, and in the long run the innocent car user, who has already paid for a shoddy casting, has now a heavy repair bill to meet, and all the initial saving is more than swallowed up, not to name the contingent expense of a breakdown of a car in a strange town. Cheap material in a motor car is the worst form of parsimony that it is possible to imagine. We would caution all would-be purchasers to see to it that when getting competitive prices they compare specifications, and make special inquiries and demand guarantees that the parts of the motor are forged steel of well-hammered quality. If they do not do this they will probably find themselves stranded miles from home just so many times as their cars contain details of improper cheap material. After this painful process has been repeated sufficiently often, and all faulty details have broken and been properly replaced, the car owner will have paid for his experience in structural materials at a very high rate.

The habits of the motor car makers are distinctly to be classed as those of the modern hustler. Cheapness is the first requisite. Men who cannot afford a horse and trap and servant think they can run to a motor car, and they try to get it cheap; the makers give way to the attack and supply the cheap car with inferior parts, which proves so costly in the long run. In its very nature the motor car is so much heavier than we all think it ought to be, that there is a tendency to minimise weights as in a torpedo boat. But the torpedo boat is not skimped in material. Its motors are made of the best, and every care is supposed to be taken to see that the best really is secured.

Now, starting from already minimised dimensions, the motor car is already quite slight enough, and it is quite unwarrantable to use anything less than the best of material. We cannot think, then, that any car maker can be so foolish as not to know that the cheap method of construction invites early and disastrous breakdown, even if the disaster only extends to an hotel bill at a strange town, a railway charge for carriage home, and a repair bill. To most men who buy a cheap car these extra charges are at least a severe tax, and a tax not the more agreeable because due to what really amounts to little better than misrepresentation. The car maker knows, and ought to tell his customer. Malleable cast-iron may be tough, it may be capable of being heated and forged to some extent, but it has no elongation and reduction of area on test, and it is an utterly uncertain and unreliable material to employ, whether made in this country or in America. We know both sorts, and do not write without reason.

Cast malleable is better than plain cast-iron. Its proper use is where cast-iron is a suitable material, and the maker or user wishes to do better. There it is justifiable, but it is never justifiable when used as a substitute for wrought-iron or steel, and much cast-steel is to-day so faulty, that it is not fit to use as a substitute for forgings. It is a thousand pities that, when purchasing supplies from America, the quality of materials and amount of finish are not better known. Consulting engineers who are so punctilious in regard to English articles, are doing their best to kill English business, because they accept American goods without examination. They want English quality at American prices, and the American will be the first man to admit that it cannot be done.

THE VELOCITY OF THE RÖNTGEN RAYS.

The theory of the Röntgen rays, which, up to the present, has received most general acceptance is that of Stokes. According to Stokes' theory, the Röntgen rays consist of irregular waves produced by the impact of cathode particles. The difference between Röntgen rays and light corresponds to the difference between noise and music as produced by sound waves. If this theory is correct, we should expect the velocity of Röntgen rays to be the same as the velocity of light. This has quite recently been shown to be the case by M. Blondlot, whose ingenious method of demonstrating this important result is described in the *Comptes Rendus* of October 27th and November 3rd. It is well-known that the Röntgen rays dissociate the molecules of air through which they pass, and thereby increase its electric conductivity. M. Blondlot took advantage of this property to determine the velocity of the Röntgen rays. The rays were caused to act upon the spark gap of a Hertz resonator, excited by another spark gap, in parallel with and lying between the focus tube and an induction coil. By suitably regulating the spark gap of the exciter, it is possible to make the focus tube and the exciter work simultaneously, but the focus tube is extinguished immediately after the spark begins to pass, owing to the fall of potential between the leads. The E.M.F. at the spark gap of the resonator is a quarter period behind the current in the exciter, and, consequently, it is necessary to delay the extinction of the Röntgen rays at the resonator gap, if they are to have any effect in making the spark brighter. This may be done in two ways:—(1) By increasing the distance between the resonator gap and the focus tube; (2) by increasing the length of the wires conveying the current waves between the exciter and the focus tube terminals. In the first case, the delay in the extinction of the Röntgen rays at the resonator gap is due to the time required by the rays to pass from the focus tube to the gap. In the second case, the delay is due to the time required by the electric waves to pass along the wires from the exciter to the focus tube. M. Blondlot adjusted the length of the wires and the distance of the focus tube till the maximum brightening of the resonator spark was obtained. Then he lengthened the wires and reduced the distance of the focus tube till the maximum brightening was again obtained. If the velocity of the Röntgen rays is the same as that of the electric waves in the wires, then the increase of the length of the wires should be the same as the reduction of the distance of the focus tube. Numerous experiments made by M. Blondlot showed these two distances to be practically equal. This shows that the velocity of Röntgen rays is the same as the velocity of Hertzian waves in a wire; and the latter is known to be the same as the velocity of light.

The theory of Stokes receives strong confirmation from these experiments of M. Blondlot. Osborne Reynolds has recently propounded the theory (in his Rede lecture) that the Röntgen rays are longitudinal waves of the ether, and are thus distinguished from light waves, which are transverse. Röntgen rays as well as light waves are, according to his view, emitted by the sun, but the longitudinal rays are damped out very quickly, and do not therefore penetrate far into space. This is to be regretted, as we might have been able otherwise to have learned something of the internal constitution of Mercury and Venus. But, on the other hand, we are saved from too realistic views of the interiors of terrestrial objects.

If Reynolds' theory is right, the longitudinal waves which constitute Röntgen rays must be irregular, *i.e.*, they must correspond to etheric noise, not to etheric music; otherwise, as Stokes has shown, the Röntgen rays would be refrangible, which experiment has failed as yet to show.

We have evidently of late been making some progress towards a knowledge of the real nature of the Röntgen rays, and M. Blondlot's experiments will undoubtedly contribute greatly to this result.

ELECTRIC HAULAGE ON CANALS.

At the ninth International Congress on Navigation, held this year at Düsseldorf, M. Léon Gérard read a paper dealing with the results obtained with electric traction on the Belgian canals. As the canal to which the paper particularly refers is the one joining Charleroi and Brussels, it will not be out of place to give a few particulars of the electric system in operation on this waterway.

The haulage system comprises a number of small electric cars running along the ordinary towing path without rails, and a few electric tug-boats for service on those parts of the canal where cars would be impracticable. The central station at Oisquerqe supplies three-phase current at a pressure of 6,000 volts; three transformer sub-stations bring this pressure down to 600 volts. The motors both of the boats and the cars take the current from the overhead

conductors through three separate trolleys. As the canal passes through a thickly-populated industrial district, part of the electric energy produced at Oisquerqc is supplied to the neighbouring factories for lighting and power purposes.

The electrical installations of the French canals, mention of which is made in the course of the article, comprise two small generating stations, each containing four sets of 50 H.P., and delivering direct current at a pressure of 500 volts. The electric energy is used only for canal haulage purposes.

The efficiency of the motor cars, *i.e.*, the relation of the work measured at the coupling-hook to the work done by the electric motor, averaged 0·484 after a year's service. This is a better result than was obtained with the old style of tractor used on the Deule Canal in France, the average there being 0·423. This improvement is entirely due to the superior construction of the car, as the tractors of both installations were built on the same principle. It is evident that the efficiency of the motor car must vary inversely as the coefficient of friction of the towing-path along which the car travels, and in this respect the French system is much in advance. The coefficient of friction for the French towing-path amounts to 7·8 lbs. per ton, while the Belgian installation shows as much as 16·5 lbs. per ton. Consequently the mechanical efficiency of the Belgian motor car is slightly higher than that of the French machine, a fact that the above-given figures do not show. During the year 1901 the boat-mileage on the Charleroi-Brussels canal amounted to 127,731 miles, the number of kilowatt-hours as registered at the station switchboard to 517,629 ; this gives an average of 4·05 KW.-hours per boat-mile (2·515 KW.-hours per boat-km.). This figure must necessarily include the quantity of energy consumed by the cars when travelling without a boat attached, the distance thus covered being estimated at about 20 per cent. of the total mileage. Running at a speed of 2·4 miles per hour under no load, the power supplied to the car, measured at the motor terminals, was 4,100 watts, the figure rising to 4,850 watts when the car is towing a boat of 70 tons at the same speed. There is, therefore, a consumption of 1·212 KW.-hours per boat-km. (1·93 KW.-hours per boat-mile). Comparing this figure with the 2·515 KW.-hours (4·05 KW.-hours per mile) given above, it becomes apparent that about half the energy is absorbed by line losses, transformers, &c.

The price of the KW.-hour supplied by the central station is valued at 0·09 fr. (0·864d.), the coal costing 15 fr. (12s.) per ton.

The maintenance cost of the towing-path for 1901 amounted to 15,275 fr. (£611) for labour, and 18,979 fr. (£759 3s. 5d.) for material (gravel, &c.), making a total of 34,254 fr. (£1,370 3s. 5d.). This shows an expenditure of 1,903·02 fr. per km. (£124 11s. 2·4d. per mile), the total distance being 18 km.

Wheel-renewal of the tractors is also a big item, for the rims become very much worn after 10,000 km. (6,000 miles), and disappear entirely after travelling 18,000 km.

The 600-volt polyphase motors require but little outlay, unless the car should fall into the canal, which would necessitate the re-winding of the coils of about 3 per cent. of the motors.

The total maintenance cost for 1901 was :—

Workshop labour	3,552·60 fr.	(£142 2s. 1d.)
Labour on towing path ...	6,601·00 fr.	(£264 0s. 9d.)
New material	2,347·00 fr.	(£93 17s. 7d.)
Total	12,500·60 fr.	(£500 0s. 5d.)

Taking the total length of line as 18 km. (11 miles), the cost per km. amounts to 694·46 fr. (£45 9s. 2·09d. per mile).

Towing with Tractor Running on Rails.—Some experiments were made at Oisquerqc on an experimental track. The wheels of the motor car which usually runs on the towing-path were removed and replaced by tramway wheels, converting, therefore, the motor car to all intents and purposes into a locomotive. The rails were of the Vignoles type and were laid 0·92 m. (1 yd.) apart. Nothwithstanding that guide-pulleys were used, and that the canal is about 30 yds. from the track, it was found that the boats could be started in 45 seconds. Basing his arguments on the actual results obtained with motor cars and on the results obtained with experimental tractors on rails, M. Léon Gérard is able to bring forward several interesting deductions.

To haul a boat of 70 tons at a speed of 2·4 miles per hour 4,000 watts had to be supplied to the locomotive. The motor car working under the same conditions required 4,850 watts, and its mean efficiency was 0·484 ; consequently the efficiency of the same apparatus on rails was :—

$$\frac{0{\cdot}484 \times 4{,}856}{4{,}000} = 0{\cdot}585.$$

Under no load the locomotive required 2,000 watts, about half the amount used by the motor car in the same circumstances. For these two reasons the quantity of electrical energy required was considerably less in the case of the locomotive system. Taking the case of an installation 47 km. (29 miles) in length, on which the traffic would amount to 493,720 boat km. (306,601 boat miles), the annual cost of electric energy, amounting to 1,240,000 KW.-hours with motor cars consuming on an average 2·515 KW.-hours per boat km., would be reduced to 991,000 KW.-hours when employing tractors on rails. If the cost were taken at 0·09 fr. per KW.-hour, the annual saving realised would be 476·8 fr. per km. (£30 12s. per mile).

Further, there is the possibility of reducing the size of the power house. According to M. Gérard, 270 KW. could be replaced by 200 KW., which would correspond to a saving of 2,488 fr. on interest and sinking fund (taken at 6·22 per cent.) ; per kilometre of canal, the annual charges would be diminished by 52·93 fr.

The charges for maintenance of rolling stock may, as is the practice with tramways, be estimated at less than 30 per cent. of the maintenance charges of the motor cars. Consequently, these charges being fixed at 694·46 fr. per km., the saving on locomotives would amount to 486·12 fr. (£31 4s. per mile).

The maintenance of the towing-path for the motor cars, which is an exceedingly heavy item, would be replaced by the charges for the maintenance of the track. This may be estimated at 4 per cent. of the value of the line, 8,000 fr. per km. (£514 per mile), making 320 fr. per km. (£20 10s. per mile) ; hence a further saving of 1,583·02 fr.

The total saving per kilometre would amount to :—

476·80 + 52·93 + 486·12 + 1,583·02 = 2,598·87 fr. (£167 per mile).

Electric Tug-Boats.—M. Gérard states that, from a practical point of view, these tug-boats have been very satisfactory. They are employed on that portion of the Belgian Canal which lies in the town of Hal, the length being from 1 to 2 miles. The boats have a capacity of 12 H.P., and draw only about 2 ft. of water. They are easily operated, and can move at a distance of 30 yards from the trolley line without difficulty. Their maximum speed is about 6 miles per hour.

The following are the conclusions M. Gérard has drawn from his experiments :—

1. That the "motor-car" system of haulage is very unsatisfactory, owing to the heavy working and maintenance expenditure, and to the amount of power required to overcome the imperfections of the road.

2. That the "locomotive" system of haulage is practicable as far as both the economical and the technical sides of the question are concerned.

3. That the "tug-boat" system has given good results, and is to be recommended for service on crowded and sinuous canals.

4. That a lighting and power distribution scheme in conjunction with the traction installation would considerably increase the profits of the undertaking.

Keighley.—The T.C. has passed almost unanimously a scheme for application for powers to convert all the existing tramways for electric traction and to construct new lines at a total cost of £32,469. To an inquiry from the Mid-Yorkshire Tramways Co., Ltd., the Council has replied that it dissents from the company's Bill.

THE ATMOSPHERE OF THE CENTRAL LONDON RAILWAY.

Acting upon instructions received from the *Daily Mail*, Mr. D. A. Sutherland, F.I.C., F.C.S., &c., has recently made a number of tests upon the proportion of carbon dioxide (carbonic acid gas) in the atmosphere of the "Tube." His results are as follows:

	No. of analyses.	Parts of CO_2 in 10,000 of air by vol.
In street	1 ...	2·83
During limited traffic—		
On platforms, 8.50 a.m.	2 ...	4·23
„ 7 p.m. (Saturday)	2 ...	3·74
In lift at Bank, 10.10 a.m.	1 ...	7·36
In carriages from City, 9 a.m.	1 ...	4·33
„ to City, 1.30 p.m.	1 ...	5·33
During heavy traffic—		
On platforms, 4 to 7 p.m.	7 ...	11·04
In carriages to City, 9.30 a.m.	1 ...	16·65
„ to City, 4 to 5 p.m.	3 ...	13·74
„ from City, 6 to 6.45 p.m. ...	6 ...	15·54
„ from City, maximum	1 ...	20·46

Commenting on these figures, Mr. Sutherland says: "the general conclusion to which I am forced to come is that the condition of the atmosphere of the Tube during the period of heavy traffic is insanitary and injurious to health."

During October, 1901, Dr. A. Wynter Blyth, Medical Officer of Health for Marylebone, made a number of similar determinations. His figures ranged from 6·03 parts of carbon dioxide at the door of the sub-station at Notting Hill Gate to 10·7 parts on the Bank platform and in one of the lifts containing 33 people; with a maximum of 11·9 parts in a carriage containing 27 people between Lancaster Gate and the Marble Arch. But just as Mr. Sutherland omits to say how many persons were in the carriage which he found to contain 20·5 parts of carbon dioxide, so Dr. Blyth has not informed us at what time of day his tests were made—and this is most important. If captiously inclined, we might be disposed to view Mr. Sutherland's determinations with some suspicion, because of his extremely low limit for the carbon dioxide in the open street. Ordinary good air contains about 3·4 parts of carbon dioxide (Fittbogen and Hasselbarth, and Farsky), with a minimum of 2·94 parts (Reiset); but the London atmosphere usually contains 4 parts, which may rise in anticyclonic weather to 6, 5 being, perhaps, a fair average. On the whole, however, we must accept both Dr. Blyth's and Mr. Sutherland's figures, accounting for the differences by differences in the time of day, different temperatures and different concentrations of traffic.

In attempting to ascertain what amount of impurity in the atmosphere is actually injurious to health, we are met with what appears at first sight to be irreconcilable differences in the views held by the best authorities. By any process of combustion or respiration, oxygen is removed from the air at the same time that carbon dioxide is added to it; but the latter effect is more important to the human being. Brown-Séquard and D'Arsonval, whose work, however, in another branch of this question has fallen into disrepute, have stated that human beings can actually tolerate without marked discomfort or permanent ill-effect air containing 20 parts of carbon dioxide for two or three hours at a time; and various other physiologists have found proportions of 4·0 parts (Marcet) or 8·0 parts. (Kronecker and Jordi) not to render air irrespirable. In the old experiments carried out by Angus Smith in 1869 upon the atmosphere of the "Underground" in carriages between Gower Street and King's Cross, the figures obtained ranged between 7·8 and 33·8 (mean 14·5) parts of carbon dioxide per 10,000; while in theatres, &c., of the day he found up to 32 parts of the same impurity; and in metal mines where men were working, up to 199 parts per 10,000. At the same time that he carried out his above-mentioned tests Dr. Blyth also examined the atmosphere in other places. In the Metropolitan Tunnel between Gower Street and King's Cross he discovered 25·9 parts; in the Council chamber of the Marylebone Town Hall containing 56 persons, he found 14·9 parts half-an-hour after a meeting had begun; and in a small room, 12 × 5 ft., with a 2 ft. gas burner alight, 33·3 parts of carbon dioxide. It will be seen that these maximum values all exceed those quoted by Mr. Sutherland, whereas Angus Smith's figures for the Underground and Dr. Blyth's value for the Council chamber are practically identical with Mr. Sutherland's mean for the Tube. Some determinations of the amount of carbon dioxide in the terribly overcrowded third-class carriages of our suburban steam railways would probably show astonishing figures; but the fact that other places of public resort are equally or more impure than the Tube is no proof of the perfection of the latter. It might be argued that the air of the Tube cannot be harmful to health because the hand-lamps used for signalling still burn freely; for it is now known that an average man can bear an atmosphere which extinguishes oil lamps—such extinction occurring when the air contains 15—16 per cent. of oxygen, 80—81 per cent. of nitrogen, and 3 per cent. (*i.e.*, 300 parts per 10,000) of carbon dioxide. This, indeed, is essentially the composition of human expired breath, which is fit for a second inspiration, though not desirable.

Nevertheless, it must be honestly admitted that there is a physiological difference, or a difference partly physiological in character, between air contaminated with a certain percentage of carbon dioxide evolved from human bodies, and air contaminated with the same percentage produced by the combustion of coal or gas. Richardson thought that oxygen was "devitalised" by passage through the lungs, which is a chemical impossibility. Brown-Séquard and D'Arsonval believed the carbon dioxide of expiration to be accompanied by a specific poison; but, in proper conditions of health and cleanliness, this has been proved incorrect, whence it should apparently follow that the carbon dioxide of combustion and of respiration must be identical physiologically as it is chemically. Still, the best authorities, such as Halliburton, agree that air rendered so impure by respiration as to contain eight parts of carbon dioxide per 10,000 is very unwholesome; other investigators putting the safe limit at 10 parts, and considering 50 parts to be quickly harmful. De Chaumont's maximum degree of impurity—viz., six parts for occupied rooms—quoted by Mr. Sutherland, is now recognised to be too severe. Dr. Blyth suggests three parts more than that contained in the outside air as a fair proportion, four parts more than the atmosphere being the ultimate limit. As the natural London atmosphere may contain six parts, this also gives 10 as the outside figure for an atmosphere which is to be breathed for any considerable period of time. Idiosyncrasy and habit play so large a part in all questions of this kind that it is extremely difficult to lay down conditions at once fair to the company, to the average member of the public, and to the sickly or neurotic individual. Probably 10 parts of carbon dioxide per 10,000 meets all cases, and upon this basis we shall argue.

The atmosphere of the C.L.R., unlike that of the Underground, or of a gas-lighted church or theatre, is contaminated wholly by human exhalations. It has to include among its passengers a very large proportion of the "great unwashed." The exhalations of the man who is healthy and clean in person and raiment contain nothing worse than pure carbon dioxide; but those of the individuals whose skin is uncleansed, whose attire is saturated with stale perspiration, and whose teeth and digestive organs are out of order, are exceedingly offensive to the nostrils. Cases of infectious disease, of course, excluded, it is not at all probable that such exhalations are specifically toxic; but by long-continued inspiration they produce lassitude, and eventually anæmia, a condition in which everybody becomes more liable to specific contagion. Even in small doses, so intimate is the connection between brain and body, a nauseous odour of human origin upsets the stomach of a nervous person, and makes him ill by sheer disgust if not by an involuntary act of self-protection; although that odour may fail to affect the man of average strength. There are people who cannot travel in train, tram or omnibus, for this reason alone, as every physician knows; but common sense tells us that the cause is subjective rather than objective. It cannot be denied that the atmosphere of the C.L.R. is competent to produce—does occasionly produce—half-mental, half-physiological distress to specially sensitive human beings, women in particular. The figures given by Mr. Sutherland as well as Dr. Blyth's solitary determination in a tube train explain this; for, unfortu-

nately, they show that at least inside the carriages at the busiest times of the day the atmosphere of the C.L.R. exceeds the permissible limit of impurity. The objection to it is not to be based so much on the high proportion of carbon dioxide, which of itself is a relatively innocuous substance, as on the quantity of odoriferous organised matter with which the carbon dioxide is accompanied, and of which, in the present state of chemical physiology, the proportion of carbon dioxide is almost the only quantitative symbol.

It may be argued for the company that if, as we are informed, there is only 2 per cent. of illness among the 500 employés who are at work all day long in the tube, the atmosphere cannot be bad enough to affect the most delicate passenger, who spends 30 minutes underground at the utmost. The men, however, are in the tube itself; the gravamen of the charge brought against the railway depends on the composition of the air within the carriages. If better exchange of air as between the coaches and the tunnels could be brought about without the causation of severe draughts, the essence of the *Daily Mail's* complaint would be removed.

We believe that the owners of the C.L.R. are keenly alive to the situation, and have not been waiting for a daily paper to teach them their business. The company is apparently doing everything that is possible, all that engineering and scientific skill can suggest to make the atmosphere more pure. There is probably no branch of applied science so obscure and complicated as that of ventilation; and the ventilation of a tunnel, 6 miles long, and 60 to 90 ft. below ground, with its numerous apertures not placed just where ventilating engineers would like them, and not constructed in the best manner to act as simple ventilating shafts—a tunnel in which the production of "humanised" carbon dioxide has exceeded all expectations*—was a problem of unparalleled magnitude before the inception of deep level electric railways. Since the date of Dr. Blyth's investigation, the fan at Shepherd's Bush has been erected. It is calculated to extract 100,000 cub. ft. per minute, or to renew the whole atmosphere of the Tube in an hour. Unfortunately, the full effect can only be felt at night, when all intermediate apertures between the Bank and the fan inlet are closed; in the daytime there will be "leakage" at each station, and therefore this fan alone, even aided by that at Notting Hill, will not serve to maintain the atmosphere all day long at the early morning purity. But the company is also about to instal an air compressor at the Bank, which will lead fresh air under pressure into the dead end of the Tube, and this should make a great difference in the atmosphere at the City end. Seeing that the wayside inlets to the Tube cannot be closed during the day, it would appear that the plan of driving fresh air in should be more economical than that of drawing stale air out; because all the fresh air must enter, while the fan may exhaust a considerable proportion of fresh air which has only just been admitted by the stairways of the nearest station.

The principle on which the line is built, each train acting as a piston in its own tube, is vastly superior to that of the Underground, and Dr. Blyth's tests, which indicate a maximum velocity of the air current set up by an approaching train of 5·79 miles per hour, show that the principle works. In theory, the advancing train should push the foul air up the lift wells and staircases, &c., to the street; in practice, the train drives much of it into the other tube *viâ* the cross connections at the stations, and into the next section of the same tube; in other words, as Dr. Blyth says, the tunnel air is diluted, but the whole of it is never swept out (*i.e.*, by the movements of the trains only). It would seem questionable whether in the original design of the stations sufficient care was bestowed upon a full utilisation of the air currents produced by the trains, with the object of minimising this wasteful backward and forward movement. Now that the line is built, we should not venture to say that any alteration in this direction is possible; even in the first instance it would have been an extremely difficult matter to arrange without the aid of doors and automatic partitions. Still, when the plans for future tube railways are being prepared, our most competent and experienced ventilating engineers ought to be consulted to see if there is no way of deriving full advantage from the elegant method of making each train its own air-pump without the high proportion of leakage which undoubtedly exists on the C.L.R., and yet without the employment of an impossibly complicated system of air-tight doors.

We cannot honestly say that we are satisfied with the condition of the Tube atmosphere at the busiest times of the day; but, on the other hand, we fail to feel the symptoms of panic which the article in the *Daily Mail* is apparently intended to impart. We presume that our authorities have power to prosecute the directors of the Tube on a charge of manslaughter at least if they allow their employés to be suffocated. We cannot be expected to believe that members of the public have only the foresight and devotion of the *Daily Mail* between them and wholesale massacre. But when we find that the C.L.R. is asphyxiating its men by making them remain in a toxic atmosphere for eight hours or more a day, we shall begin to consider more seriously whether its passengers are being ruined in health by their two daily journeys of half an hour each.

* The C.L.R. is carrying 150,000 passengers a day; the bulk of them in two periods of some two hours each.

BUSINESS NOTES.

Otis Elevators.—Lord Cadogan has recently had one of the "Otis" electric elevators fitted at Chelsea House. These lifts have also been adopted by Sir H. Seymour King at 9, Pall Mall; the Duchess of Marlborough at Blandford House; the Hon. F. D. Smith at 3, Grosvenor Place; Lord Wimborne at Wimborne House; and Lord Wolverton at 26, St. James's Place.

Killarney.—In the Dublin Court last week, before the Master of the Rolls, the case of Callender's Cable Co. *v.* Killarney Electric Lighting Co. was heard. The action was brought by plaintiffs to wind up the company. Mr. Goodman had been appointed receiver, and since his appointment, certain claims had been made on him for debts and liabilities incurred previous to his taking up office. The plaintiffs sought to recover money due to them, but the Master of the Rolls only ordered £10 to be paid to the Board of Works, and other debts to stand over.

Rowland Carr & Co.—This firm has obtained the sub-contract for the cast-iron bases in connection with the lighting and traction work at Buenos Ayres; also the order for the necessary cast-iron pipes in connection with the traction work at Barrow-in-Furness, which is being carried out by the British Insulated Wire Co. Messrs. Carr are also supplying the refined Trinidad bitumen for embedding the cables underground at present being laid at Bexley, Kent, by the contractors, the Anchor Cable Co.

A Carbon Gauge.—We have received from the Union Electric Co., Ltd., one of their "Abeam" carbon gauges, specially adapted for measuring the diameter of carbons up to 30 mm., and marked in millimetres only. It is only 1¾ in. in length, and fits easily into the waistcoat pocket. It is a most serviceable and acceptable article.

Germany.—Messrs. Siemens & Halske, of Berlin, are declaring a dividend of only 4 per cent. for the past financial year, as compared with 8 per cent. in the preceding 12 months.

The Education Bill.—The St. Bride's Press, Ltd., will publish on the first day of the New Year a weekly paper, to be called *Education: Primary, Secondary and Technical*, which will deal mainly with the work of the authorities under the Education Bill.

Annual Dinner.—The engineering staff of the B.E.T. Co., who are the lessees of the Croydon Corporation Tramways, held their second annual dinner and smoking concert on Saturday evening at the Wheatsheaf Hotel, Croydon. Mr. J. P. Spurway, the company's resident engineer, occupied the chair.

Damages for a Lift Accident.—At Birmingham Assizes on December 16th, Messrs. Archibald Smith & Stevens, electrical engineers, were ordered to pay £300 damages to John Geo. Morgan for injuries sustained through a lift descending without warning. Stay of execution was refused.

Calcium Carbide.—The Geschäftsstelle Vereinigter Carbidfabriken, of Landgrabenstrasse, 97—100, Nuremburg, Germany, has opened a competition for the best method of packing calcium carbide. Two prizes of £50 and £25 respectively are being offered, and the competition will remain open until March 1st next. The packing method to be selected must comply with existing railway and shipping regulations, cheap, simple, water and air-tight, &c.

Change of Address.—The office of the Bradford Corporation electrical engineer has been removed to Whitaker Buildings, Victoria Square, Bradford.

Catalogues and Lists.—A small pamphlet has been issued by the Improved Electric Glow Lamp Co., Ltd., on the subject of reflector lamps, especially the I.E.G. silvered lamps.

The Westinghouse Brake Co. has sent us an illustrated pamphlet showing and describing the Westinghouse electric semaphore signal.

No. 51 of Messrs. Veritys' circulars gives an account of the firm's electric organ-blowing outfits equipped with the Aston-Lundell motor and self-contained worm gear. Prices of the different parts of an outfit are given, also a diagram showing the arrangement of a complete equipment. Some notes appeared of the horse-power required to drive bellows.

Messrs. J. Holden & Co., of Paris, who are represented in this country by Mr. E. Roubier, of 49, Sydney Street, South Kensington, S.W., have placed before us a couple of illustrated pamphlets relating to the "Max" indestructible electric accumulator for automobiles, launch, submarine boats, lighting, ignition and other purposes.

A circular of electric foot-warmers has been sent to us by Messrs. Millington & Everitt, of King's Parade, Cambridge.

The New Brotherton Tube Co., Ltd., of Wolverhampton, has just brought out a cheap seamless solid-drawn steel conduit for electric lighting, which is claimed to possess special advantages where a water-tight installation is desirable. A small list has been issued relating to same, and a copy will be sent on application.

We have received a most novel and interesting wall calendar for 1903 from Messrs. W. T. Glover & Co., Ltd., of Manchester. It is a tear-off sheet calendar, and on each day's slip there appears a quotation from the *Proceedings* of the Institution of Electrical Engineers and other sources, of interest to professional men; a number of photographic reproductions showing Glover cable-laying operations in different towns are interleaved. The compilation of the reading matter represents a great deal of labour on the part of somebody, and he will be rewarded by knowing that electrical engineers will be eager to allow this wall calendar to have the position of honour for the next 12 months, for it is essentially the electrical engineer's calendar.

The Valor Co., Ltd., of Aston Cross, Birmingham, has sent us lists of its "Filtrall" automatic waste oil filters for electric light stations, also its patent oil cabinets for engine rooms. A third list is a sheet of illustrations showing oil cans, tanks, and various other tin and iron plate manufactures. The Valor Co. also supplies drop forgings in iron and steel.

Bankruptcy Proceedings.—The public examination of Alfred Percy Archibald Hunt, electrical engineer, of Southport, took place at the sitting of Liverpool Bankruptcy Court on December 18th before Mr. Registrar Bellringer. The accounts showed liabilities amounting to £354, and assets, valuing the business at Southport as a going concern, £415. In reply to the Official Receiver, the debtor admitted that several creditors had been omitted from the statement, because he believed these did not intend to press their debts. He estimated his stock to be worth £50, and the fixtures, fittings, &c, £220. He had found that he had spent too much in fitting up his place of business, and had not left enough capital to work upon. He commenced business about seven years ago at Liverpool with a capital of £125. Six months after commencing on his own account he took into partnership Mr. H. Dangerfield, of Bradford, who found £200. Mr. Dangerfield retired last March, the debtor gave him a promissory note for his £200, to bear interest at 12 per cent. He was now a creditor for the full amount. In addition to the shops at Liverpool and Southport, they also had a place in London and works at Acton. The two latter were given up about two years and a half ago. He admitted that the London and Acton addresses appeared on the Liverpool and Southport billheads after the places were discontinued, but he denied that this was done with any intention to deceive. It had been his intention when the billheads were printed to make the London establishment his headquarters. The examination was adjourned until January 15th, leave being given for the amendment of the statement of affairs.

The case of Wm. Peter Durtnall, electrical and mechanical engineer, came before Mr. Registrar Hope at the London Bankruptcy Court on 18th inst. in relation to the public examination of the debtor, who was brought to the Court on November 8th upon the petition of creditors. The particulars of the case appeared in our issue of November 28th, the failure being chiefly ascribed to loss on a contract the debtor entered into last September for electric light and power with Messrs. Wyman & Sons, Ltd., of Reading, at the price of £1,800. Mr. G. W. Chapman, Official Receiver, reported that the debtor had not yet filed the statement of his affairs, and no reason has been given for the delay. Under those circumstances he asked for the examination to be adjourned until the next sittings, and for an order upon the debtor to file the accounts within a week. The learned Registrar granted the application, and adjourned the hearing until January 15th next.

At Sheffield Bankruptcy Court on Thursday last week, the examination of Thos. Edward Morgan, electrical engineer, of 367, Eccleshall Road, Sheffield, was adjourned until January 15th.

Dissolutions and Liquidations.—Messrs. L. Marston and R. H. Jones (Marston & Jones, electrical and mechanical engineers, 68, Birmingham Road, West Bromwich), have dissolved partnership.

A circular has been issued by the board of the Coventry Electric Lighting and Engineering Co. calling a special meeting for the purpose of considering a resolution to wind up voluntarily, and appointing a liquidator.

The Electrical Copper Co. is winding up voluntarily with Mr. G. Trevert, of 1, Abchurch Yard, E.C., as liquidator.

The Electrical Power Distribution Co. is winding up voluntarily for the purposes of the absorption by the B.E.T. Co., announced some time ago.

Trade Announcement.—Messrs. H. V. Kramer & Co., of Bath, have issued a new illustrated list of their small three-phase motors with ball bearings. They have now opened, in addition to the Bath and Manchester branches, offices in Glasgow at 110, Brunswick Street, and in London at 9 and 10, Wells Street.

ELECTRIC LIGHT AND POWER NOTES.

Amersham.—The R.D.C. has given assent to the application of the Uxbridge and District Electric Supply Co. for a prov. order, to extend its area of supply to the Chalfonts and other parishes in Herts. and Middlesex.

Austria.—A central electric lighting station has just been completed in the town of Lilienfeld. The electrical part of the work was supplied by the Austrian Union Electrical Co., of Vienna, and the turbines—water-power being utilised—by Messrs. Ganz & Co., of Buda-Pesth.

Bath.—The City Council has resolved that Mr. Manville be engaged to advise the authority upon the electricity works extensions which should be carried out forthwith, Mr. Teague being associated with him in the execution of the work.

Brighton.—Before sanctioning a loan of £375 for illuminating the entrance to the Aquarium by electricity, the L.G.B. has asked for a detailed estimate of the cost, showing the number and kind of lamps to be used. The T.C., while instructing the electrical engineer (Mr. J. Christie) to supply the information, has decided to proceed with the work without waiting for the sanction for the loan.

Briton Ferry (Glam.).—The D.C. has appointed Messrs. Lewis & Fletcher, Cardiff, as consulting engineers in connection with the plans for the supply of electricity for the town.

Brixham.—The ratepayers have decided that the U.D.C. shall apply for a prov. order for the establishment of electric light works, instead of entering into an agreement with Messrs. Crompton and Co., or purchasing the gas works.

Cannock.—The U.D.C. is asking the B. of T. to extend the time for utilising the Council's powers in respect to the provision of the electric light under the prov. order for a further period of 12 months.

Cardiff.—So many applications for the supply of electricity are being received by the Corporation from private consumers, that the electrical department is finding it difficult to cope with the demand. Respecting the negotiations with the Board of Guardians for an installation at the workhouse, Mr. Ellis has recommended a charge of 3d. per unit for an annual consumption of 25,000 units, with an additional charge of ½d. per unit for every 1,000 units below that figure, all units for the first, second and third quarters to be charged at 3d. per unit, and at the end of the year, should the consumption not reach the minimum, the account to be adjusted according to the scale. The Cardiff Railway Co. has declined the rates offered by the Corporation for supplying electricity to the Bute Docks. Mr. Ellis has recommended a prepayment meter for small consumers at the rate of 6d. per unit, which would obviate the minimum charge of 13s. 4d. per quarter as meter rent, and the committee has decided to adopt the slot-meter system.

Chesterton.—The R.D.C. on December 18th passed a resolution consenting to the application of the Cambridge Electric Supply Co., Ltd., for a prov. order authorising the company to supply electricity in the parishes of Cherryhinton, Coton, Fen Ditton, Girton, Grantchester, Great Shelford, Histon, Impington and Trumpington.

Colwyn Bay.—It has been resolved to apply for sanction to borrow £2,680 for electricity works extension.

Coventry.—In the last half-yearly report of the Coventry electric light undertaking there is a decided financial improvement. The trading for the half-year ended September 30th, as compared with the same period of 1901, shows a saving of £941. In other words, the demand on the rate is £1,082, instead of £2,023. Considerable economies have been effected. The cost of generation has been reduced from £2,151 to £1,572, and some 36 per cent. more electricity has been sold. The works costs amounted to 1·61d. per unit metered, and the total cost of production to 2·54d.; but the heavy standing charges, with a trifle for maintenance of public lamps, bring the total cost per unit slightly over 6d. The manager of the works, Mr. J. A. Jeckell, has reported to the Corporation at considerable length with regard to the working economies which he has succeeded in effecting, and the increase of the supply to motors, which he is pushing energetically. The horse-power of motors connected and applied for since his appointment has now reached over 184 H.P., the demand being considerably assisted by the prospect of a two-phase supply in the near future, the plant for which is in place at the works. The capacity of the plant has been increased

from 550 to 1,800 kw., and the cost per kilowatt of earning capacity has been decreased from £217 to £126. Mr. Jeckell is making a brave uphill fight, and we congratulate him on the success so far achieved.

Before the Coventry Engineering Society on Friday evening, Mr. Jeckell gave an interesting lecture on "The Generation and Use of Electrical Energy." Mr. Jeckell first dealt with the price at which the illuminant can be sold, and said that, if charged for on the maximum demand method, there is likely to be no great difference between the cost of electricity and that of other means of illumination; in fact, to what are known as the long-hour customers, the price is more favourable than that of any other illuminant. Electric heating was briefly touched upon, and the subject of electric driving of factories was discussed at length, after which Mr. Jeckell exhibited slides showing the station at South Shields, which he regarded as one of the most up-to-date stations in the United Kingdom. At the close of the lecture, Mr. Jeckell was accorded a hearty vote of thanks. On Saturday the Society visited the Coventry Electricity Works.

Dartford.—The U.D.C. has adopted alternative terms for wiring consumers' premises. If the consumers desire to purchase outright, only cost price is charged, and the alternative terms are a rental of 1s. 3d. per annum on each £1 expended. This is very nice for the customers; but what say those ratepayers who are also wiring contractors?

Falkirk.—The T.C. has approved of a proposal from the E.L. Committee and the Lighting Committee to introduce Nernst lamps, by fitting these to the present lamp standards in High Station Road. If this system of lighting turns out well, it may be adopted all over the town. Each lamp is estimated to cost 55s. for everything, while, at the present time, each costs about 30s. for gas alone, and there are the lamps and the wages of lamp-lighters as well to pay for.

Fleetwood.—The U.D.C. has decided to light the public slaughter houses by electricity, and to erect 24 new electric lamps for street lighting.

Foot's Cray.—The U.D.C. has requested Messrs. Preece and Cardew to submit an independent report upon the Woolwich and Bexley schemes for supplying Sidcup with electricity in bulk.

Gainsborough.—The U.D.C. has decided to abandon for the present the proposed application to the B. of T. for a prov. order to supply electricity in the town. Two companies which had given notices of their intentions to apply for a similar order have intimated that they are not proceeding with their applications.

Hove.—On Saturday last the B. of T. held an inquiry respecting the application of the Hove Electric Lighting Co. for power to compulsorily raise the supply pressure from 110 to 220 volts. It was stated on behalf of the company that out of 1,038 consumers, 919 had already taken a supply at 220 volts, and there were 119 still on the lower pressure, of whom 23 had agreed to make the change, subject to the necessary permission of the Town Council. As compensation for the change, the company agreed to decrease the price of the first-hour units by 1d. It was intimated, however, that as soon as the increased voltage came into force, the directors of the company would see their way to make a substantial reduction in the charge for electricity.

Huddersfield.—The Corporation has received the sanction of the L.G.B. to borrow £5,000 for the purchase of motors and appliances. At a meeting of the Council on 17th inst. it was resolved to make an application to the B. of T. for a prov. order to supply electricity to the adjoining urban district of Linthwaite.

Ipswich.—The T.C. has received from the L.G.B. sanction to borrow £69,000 for E.L. purposes. It is proposed, when the supply is commenced, to supply energy at 6d. per unit for lighting, and 2d. for power. October 1st next is given as the date when it is hoped to commence the supply.

Kingston.—The T.C. has resolved that Mr. H. R. J. Burstall be appointed to report on the electricity undertaking, at a fee of 100 guineas. It was further resolved to apply for sanction to borrow £7,784, to cover liabilities which have been incurred by the committee in excess of the loans already sanctioned.

Lambton Castle.—A new E.L. plant has been fitted up at Lambton Castle for Lord Durham, under the direction of the resident electrical engineer, Mr. J. D. Murray. The dynamos were supplied by Messrs. Crompton & Co., and the compound vertical engines by Messrs. Belliss & Morcom, Ltd. In the Castle there are 1,000 lights.

Leeds.—A Sub-Committee of the Corporation Lighting Committee is considering schemes and estimates for lighting all the tramway routes within a radius of a mile from Boar Lane with arc lamps.

London.—St. Pancras.—The electrical engineer of the Borough Council (Mr. S. W. Baynes), in a report presented to the Council last week, advised that the Electricity Committee should light all streets having distributing mains by electricity, and with incandescent gas only those streets wherein distributing mains are not likely to be laid. Consideration of the report was deferred.

Hammersmith.—The Corporation has passed a resolution approving of the renewal of the L.C.C.'s application to Parliament to enable the Councils of the Metropolitan Boroughs to wire and fit consumers' premises for electric light, and to obtain loans for that purpose.

Hackney.—The total amount expended up to date by the Borough Council on capital account for electric lighting is £294,427. In addition, a loan for £25,000 is about to be taken up for the purpose of increasing the generating plant.

Maidenhead.—The E.L. works were opened on December 17th by Mr. Ernest Gardner, M.P., who, in the presence of the Mayors of Maidenhead, Henley-on-Thames and Windsor, and other leading residents of the district, started the engines and dynamos. There are already 4,500 lamps connected.

Maidstone.—The T.C. has decided to convert into electric lamps all the existing lamps which are within 60 ft. of the mains.

Newcastle-on-Tyne.—The Newcastle and District Electric Lighting Co. has just made an important addition to its plant by the installation of two new direct-current turbo-generators, which have been constructed by Messrs. C. A. Parsons & Co., of the Heaton Works. The two generators are each of 1,000 kw. capacity, the electromotive force being 500 volts, and the speed about 1,800 revolutions per minute. The generators are of the tandem form, with two dynamos each of 500 kw. capacity. The armatures are interchangeable, and the dynamos can be run independently of one another if necessary. The turbine itself is of the maker's latest improved construction, and is arranged for the full expansion of steam from the boiler pressure to that corresponding to within 1 in. of the barometer. The admission gear works in conjunction with an electrical solenoid, the latter maintaining automatically constant voltage at all loads, and so quick is the response to any change of load that it is easy to maintain the pressure within 2 per cent. of the normal. The dynamos are of the latest type and embody all improvements. The floor space occupied by each machine is 38 ft. 6 in. by 6 ft. or 231 sq. ft.

The Newcastle Lighting Committee is so well satisfied with the light given from the electric lamps on the tramway routes, that it is considering the cost of lighting the whole of the tramcar lines throughout the city by means of the electric light.

Rhondda Valley.—The South Wales Power Co. has notified the D.C. of the line of route on which it proposes to lay electric mains, and the D.C. has referred the whole matter to committee, with power to call in an expert.

Sowerby Bridge.—The U.D.C. has decided to consider the advisability of introducing electric lighting into the town, either by obtaining a supply of electricity from Halifax Corporation or by establishing its own works.

Strood.—The R.D.C. on December 17th decided to assent to the scheme of the Kent Electric Power Co.

Tipton.—A deadlock has arisen between the District Council and the Midland Electric Corporation, whose works are situated at Ocker Hill, in reference to the supply of electricity to private consumers. Some time ago an agreement was entered into between the Council and the Corporation, by which the latter undertook to supply the former with electricity in bulk at a stipulated price, and the Council considered that it was free to supply customers, out of which transaction it was proposed to make a profit. The Corporation, however, has put an entirely different construction on the agreement, which it contends has only reference to supplying the Council with current for its own use, and as it holds an Act to supply private consumers, it declines to allow the point to go to arbitration, although it is prepared for the question of the price per unit to be decided by a B. of T. arbitrator in the event of any dispute.

Tiverton.—In consequence of the B. of T. threatening to revoke its prov. order, the T.C. has received offers from four companies for leasing the order.

Walton.—The U.D.C. has decided to make application for a prov. order for the supply of electrical energy for public and private purposes.

Warmley.—The R.D.C. has decided to apply for a prov. order for the whole of the Council's area.

ELECTRIC TRACTION NOTES.

Bournemouth. — The Corporation Tramways, which cover about four miles of route, one-fourth of which, through the centre of the town, has been constructed on the side-slot system, were opened on 18th inst. It is stated that the conduit line has not yet been inspected by the Board of

Trade, but the Corporation was anxious to secure the Christmas traffic, which is always large in Bournemouth, and commenced running after two test trials over the route.

Cheshire Lines.—The railway companies forming the Cheshire Lines Committee have (says a financial contemporary) deposited their Bill for introduction into Parliament next session. The Committee propose to construct nearly a mile of new lines for the purpose of connecting their Liverpool and Manchester Railway with the Liverpool Overhead Railway. The new line will run from the Herculaneum Dock station of the Overhead Railway to a point near the St. Michael's station of the Cheshire Lines Committee. This connecting link is to be treated as part of the undertaking of the Committee, who also ask for running powers over the whole of the Liverpool Overhead Railway, together with the right to use all stations, electric current appliances, and all conveniences connected with that railway.

Douglas (Isle of Man).—The seventh annual meeting of the shareholders of the Douglas Southern Electric Tramways was held at Manchester on Thursday last week. Mr. J. T. Hutchinson presided. The report, which was submitted for adoption, stated that the gross earnings of the company had been £4,732, as against £5,026, a decrease of £293, and the net profit was £1,952, against £2,042. The directors recommended a dividend of 6 per cent. upon the 7 per cent. preference shares. The report was adopted.

Dover.—The Town Council has decided to apply for a loan of £1,250 for the extension of the electric tramways, and £573 for a new car.

France.—A system of electric tramways has lately been completed and put in operation in the town of Rodez (Aveyron department). The plant at the power station comprises two 180-H.P. Sulzer engines and dynamos.

Handsworth.—The U.D.C. has decided to support the Bill of the B.E.T. Co., by which desirable electric tramway communication with the district will be obtained.

Hove.—In spite of the rather amusing and unique circumstance announced in our pages a fortnight ago where an Alderman voted for the Council's scheme when he intended to do otherwise, and thus made all the difference as to whether the Council could go forward with their Bill or not, the scheme has passed the further stage of the statutory meeting of ratepayers. Mr. W. G. Frazer, who has all along been agitating against the Council, demanded a poll of the whole town; this has yet to come, but the opinion generally is that the "tram advocates" will obtain a majority.

Huddersfield.—The Tramways Committee has decided that five new cars now on order shall be fitted with the British Electric Car Co.'s trucks. It was ordered that Hudson life-guards be fitted to a number of cars at £6 per car. The consideration of the conversion of bogie cars into four-wheel cars, and the application of magnetic brakes to such converted cars, was adjourned.

The Finance Committee has been recommended to insure the tramway employés under the Employers' Liability Act. The total car receipts for October last amounted to £4,685, and for November last to £4,331. Two routes were partly closed for reconstruction.

Johannesburg.—The *Westminster Gazette* says that the consulting electrical engineers have submitted an exhaustive report to the Town Council, recommending the laying down of 23 miles of double track electric tramway and a new lighting plant. The total capital required for the combined undertaking is £1,240,000.

Liverpool.—On Friday last a conference, which was attended by influential residents in South Lancashire towns, took place at the Town Hall, Liverpool, the subject for consideration being the carriage of goods on the electric tramways of Lancashire. The conference had been convened by Mr. Alderman Petrie, as chairman of the special committee of the Liverpool Corporation Tramways Committee, which had been appointed to consider the question of carrying merchandise on the tramways. After an interchange of views on the subject, Mr. W. B. Hulton moved, and Dr. Sephton (Atherton) seconded, the following resolution:—

> That this meeting of gentlemen connected with various towns of South Lancashire, and the County Council of Lancashire, approves of the principle of the scheme for the transport of merchandise from the Liverpool docks to the towns of South Lancashire by means of the Liverpool Corporation and other tramways, and recommends that a committee be appointed to consider the details of the scheme, and with authority to take such action in the matter as they, in their opinion, may think desirable in the interests of the scheme.

The resolution was unanimously adopted.

Mr. Councillor Lloyd (Liverpool) then moved that a committee of 23 members, representing the industrial centres of the county, with power to add to their number, be formed. Alderman F. Smith seconded. The resolution was adopted unanimously. A meeting of the newly-formed committee followed the conference. Alderman Petrie was appointed chairman; Alderman F. Smith vice-chairman; Mr. E. W. Pierce (Deputy Town Clerk of Liverpool), hon. secretary; and Mr. C. R. Bellamy (general manager of the Liverpool tramways) hon. treasurer.

Llangollen.—The P.C. on 11th inst. gave its consent to the Shropshire, Worcestershire and East Denbighshire E.P. Co. acquiring land at Trevor for the erection of their generating station for working the lines to be constructed in East Denbighshire.

Paris.—The shareholders of the Paris Metropolitan Railway Co. have sanctioned an increase in the capital from £2,000,000, to £3,000,000, the money being mainly required to meet the growing traffics on the line. During the first 10 months of the present year, the ratio of working expenses to gross receipts amounted to 42 per cent., as compared with 47 per cent., whilst the proportion further declined to 38 per cent. in November. The dividend paid a year ago was at the rate of 15 frs. per share, and it is thought the distribution for the current period will be at least at the same rate. It is calculated that the profits for 1903 will reach a total of £200,000.—*Financial Times.*

Peterborough.—On Thursday last week the first electric car ran over the new lines.

Rowley Regis.—The U.D.C. is going to oppose the application of the Dudley, Stourbridge and District Electric Traction Co. to apply for a provisional order for the extension of the Dudley and Halesowen and District Light Railways.

Sale.—At a recent meeting of the U.C. the tramway question received some further attention. The chairman (Mr. T. F. Wainwright) reported the result of an interview with the representatives of the B.E.T. Co., and stated that on the disputed points the company had given satisfactory assurances. If the Council were favourable to the company's scheme they would agree to the erection of the generating station in Sale, and provision would be made for the ultimate supply to the district, when its contract with the Trafford Park Power and Light Co. terminated, of current at cost price, plus such a profit—say 5 to 10 per cent.—as might be agreed upon. For the fulfilment of its obligations the company would undertake to execute a bond. It was further guaranteed that the subsidiary company, the North Cheshire Tramway Co., which would be formed, in the event of the company's Bill being passed by Parliament, would be financed by the B.E.T. Co. After discussion a resolution was passed regarding favourably the reasons which the B.E.T. Co. had given for their altered scheme, but asking to be furnished with a copy of the Bill, together with all agreements and documents connected therewith, and the conditions as to running to the present Stretford terminus and through to Manchester.

Shardlow.—Sir Bache Cunard has informed the R.D.C. that he has been obliged to withdraw his scheme for the construction of a light railway from Derby to Nottingham.

The Council has appointed a committee to consider the Notts. and Derbyshire Light Railway scheme, for which the Council's assent is sought.

Smethwick.—The Town Clerk has been authorised by the T.C. to dissent from the proposal of the Dudley, Stourbridge and District Electric Traction Co., Ltd., and the B.E.T. Co. to be made to the Light Railway Commissioners for an order authorising the construction of certain light railways down Beeches Lane. On the other hand, the Council have decided to petition in favour of the Bill being promoted in Parliament by the B.E.T. Co. to secure running powers into Birmingham.

Strood.—The Strood (Rochester) R.D.C. has agreed to a proposal for the Chatham and District Light Railways Co. to run a tramline from Chatham to Gravesend, passing through Strood. The Council also considered plans for a like purpose from the Rochester T.C. and the Kent Electrical Power Co., and assented to the proposed schemes.

Swansea.—At a meeting of the Corporation Electricity Committee, the chief electrical engineer, Mr. Prusmann, presented a detailed report on the result of a visit of a number of members of the Corporation to Paris with the object of investigating the working of the Dolter surface contact system. The Committee decided to defer the consideration of the report, and in the meantime to obtain from the four companies who have surface contact systems—the Dolter, Schuckert, Kingsland and Lorain—their price per mile for laying down the systems, and the price per mile for electrical equipment.

Switzerland.—La Compagnie de l'Industrie Electrique et Mecanique of Geneva, has lately taken up the construction of electrical motor cars for industrial as well as pleasure purposes. It is also at work on a new combination petrol-electric car, which will be put on the market early in the new year. The car will be provided with a 9 H.P. petrol motor, which will drive a dynamo at a constant speed. The latter will furnish the current for the electric motors which drive the car, any excess being utilised in charging a small battery of secondary batteries.

Wrexham.—It is now understood that the electric cars will commence running on February 1st.

ELECTRICITY SUPPLY IN HASTINGS.

It is believed that the Hastings electric light works is the only public electricity generating station in the United Kingdom still in existence that has been in continual operation for over 20 years. This station was put down and first worked in 1882 by Mr. Robert Hammond, and though there is very little of the original scheme now left, the outer walls of the existing building still surround the site. A very large amount of experimental pioneering work had to be done in those early days, as the promoters had absolutely no previous experience to guide them. This, of course, entailed a heavy capital expenditure on plant which had to be scrapped long before it was worn out, and this early expenditure has been, and will be, for some considerable time a burden on the existing undertaking. Installations that have been started within comparatively recent years have been able to profit by the early pioneer work of the Hastings and other undertakings started at about the same time, and are consequently able to show much better results. Although the Hastings undertaking has suffered heavily, the town, as a whole, has profited greatly by it. There can be little doubt that the much-talked-of electrically-lighted promenade at Hastings attracted a large number of visitors to the town in those early days, and greatly increased the popularity of the place as a pleasure resort.

The site chosen for the generating station was the only one having the advantage of a railway siding that could be obtained near the area of supply. At the time when it was selected, the promoters of the scheme had no idea what the ultimate requirements of an electricity generating station would be. The original building consisted of three stories; the engines, dynamos and boilers were placed on the ground floor, with stores and offices above, and the top floor was fitted out as a suite of living rooms for the resident engineer. The floors, which were only a few feet above the boilers, were constructed of wood, and the whole structure was as inflammable as it is possible to imagine. Undertype locomotive engines were employed to drive counter-shafting by means of belts, and Brush series dynamos were driven from the counter-shafting. All the arc and incandescent lighting throughout the town was supplied by these dynamos. The incandescent lamps in consumers' houses were arranged in groups of eight in parallel, and the 2,000-volt pressure was of necessity carried right through consumers' switches, &c. As may be imagined, consumers in those days often met with some very unpleasant experiences in connection with their electric light supply!

In 1890 the Electric Light Co. applied for, and obtained, a provisional order, and then set about re-modelling their plant on what were then modern lines. The series lighting dynamos were replaced by rope-driven single-phase alternating-current generators, and a new system of mains was put in for supplying current to transformers placed on consumers' premises. No attempt was made, however, to remodel the building or to shift the plant to a more satisfactory site. It was not until 1893 that the directors' attention was drawn to the fact that the then existing building would, in a very short time, be so crowded as to make extensions impossible, and it was suggested that a fresh start should be made on a new site rather than extend on the existing one. The directors, in consequence, decided to obtain expert opinion upon what was evidently an important question, and Dr. Kennedy was asked to advise them thereon. After going very carefully into the whole question, Dr. Kennedy's advice was to retain the present station, to buy up three adjoining premises, thus providing room for future extensions, and to entirely reconstruct the building. Acting upon this advice, the company immediately bought up the adjoining property and carried out such alterations and extensions as appeared to be most necessary. Amongst other things, the existing chimney shaft was then built. The complete reconstruction of the building was not commenced until the latter part of 1899, after the purchase by the Corporation; the work was then carried out by the borough engineer on lines suggested by the electrical engineer. The two floors and the roof of the generating station were removed, and replaced by a lantern roof fixed at a convenient height to permit of the use of an overhead traveller. The wooden floors over the boilers were also taken out, and a new set of offices, coal and general stores, battery room, and test room, were erected on a concrete floor supported by steel girders and stanchions.

On January 1st, 1899, the undertaking was purchased by the Hastings Corporation from the Electric Lighting Co. As a result of the first year's working a small profit was shown after paying all interest and sinking-fund charges on the very heavy capital, but this was only done by maintaining the somewhat high rate of charges that had previously been made by the company. The Council then decided to reduce the price to something equivalent to that charged in other towns; this, however, entailed an immediate decrease of income of over 25 per cent. It was anticipated that this reduction of price would lead to such an increased demand as would compensate for the enormous reduction; to a great extent this anticipation has been justified, as during the past three years the output has increased by over 93 per cent. Unfortunately, a few months after the reduction in price was made, the cost of coal was greatly increased, and this, combined with other causes, has prevented the undertaking from showing a profit, after provision for interest and sinking fund, since the reduction was made.

The following table shows the progress of the undertaking during the past seven years:—

Year.	Output in units.	Average price obtained for private lighting.	Gross profit.
1895	265,846	... 7·6d. ...	£1,246
1896	283,100	... 7·64d. ...	1 894
1897	338,705	... 7·73d. ...	3,426
1898	363,678	... 7·65d. ...	3,302
1899	404,866	... 7·79d. ...	5,046
1900	524,830	... 5·2d. ...	3,896
1901	703,814	... 5d. ...	5,565

The boiler plant at present consists of five boilers made by Messrs. Babcock & Wilcox. Three of these are of their ordinary land type, each capable of evaporating 7,500 lbs. of steam per hour, and the remaining two are of their marine type. The latter were installed on account of the smaller floor space required. They have the further advantage of being highly economical, and as they are encased in corrugated iron shells instead of brickwork, the difficulty of preventing air leakage is very much smaller. Both of the marine type and one of the land type boilers are fitted with Babcock & Wilcox superheaters, giving about 50° superheat. A Green economiser is provided for the two marine type boilers only, the available space being insufficient to permit of the use of an economiser with the land type boilers. The whole of the boilers are inter-connected by an 8-in. steam main divided into sections between the boilers by full-way stop valves. The steam pipes to the engines are taken out of the top of this trunk main. No duplicate steam pipes are provided, though any section of pipe may be isolated in the event of a failure in that section.

Coal is obtained directly from the railway trucks on a siding adjoining the boiler house. These are emptied into a small half-ton truck, which is conveyed by an electrically-operated hoist to the coal store above the boiler house.

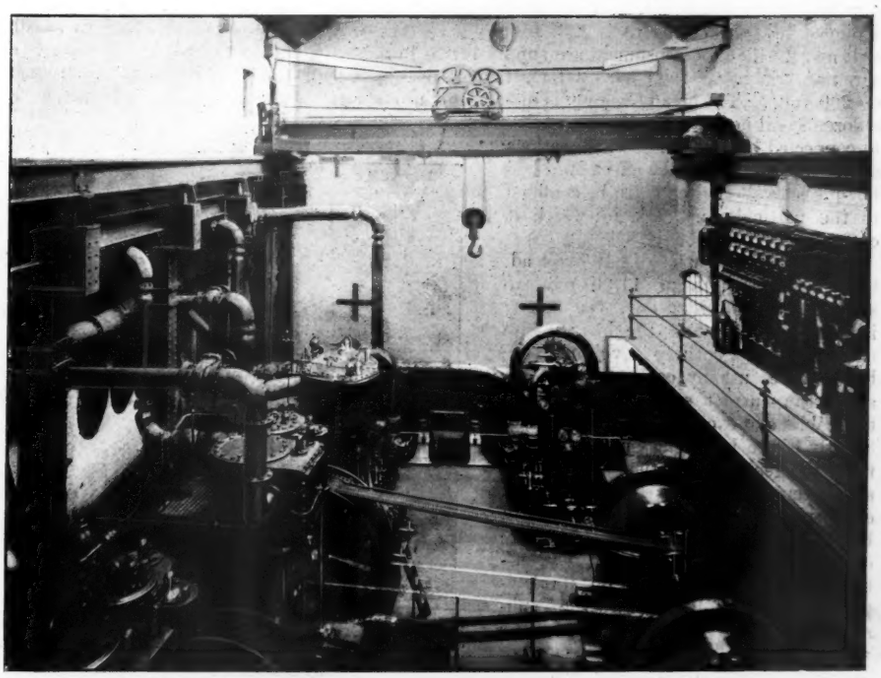
The engine-room plant consists of three rope-driven 100 KW. Brush sets, two 200-KW. direct-coupled Belliss-Brush sets, and one 500-KW. Parsons turbo-alternator. The latter has recently been erected on the site previously occupied by a 50-KW. rope-driven set, thus illustrating in a striking manner the progress made in generating plant during the last 10 years. Both the Brush sets and the Parsons set have given entire satisfaction. They run perfectly together in parallel, and are highly economical. Some doubt was felt when installing the Parsons turbo-alternator as to whether the excellent steam consumption guaranteed would be maintained in practice after some months' running. To enable the engineers to carefully watch this, a water meter was fitted in the discharge pipe from the air pumps, and daily readings have been taken of the steam consumption under all conditions of load. After 12 months' almost daily use the regular results obtained per kilowatt-hour are 22 lbs. at full load, 25 lbs. at half load, and 32 lbs. at quarter load. It is most important that every effort be made to maintain a good vacuum on this type of generator. It has been found that running a heavy eight-hour shift without the condenser will make a difference of over £2 in the cost of fuel for the run.

As no plentiful water supply is available for condensing, the town water is used for this purpose, and a tower has been erected for cooling the circulating water. The plant for this purpose was supplied by the Wheeler Condenser and Engineering Co., and the reduction in temperature of the cooling water is sufficient to maintain a vacuum of from 27 to 28 in. in the steam turbine when working under full load conditions. Arrangements are made for circulating the water from the cooling tower, by means of a centrifugal circulating pump on the roof, either through the Parsons condenser, which is fixed in a chamber directly under the turbine, or through the Wheeler condenser provided for the Belliss engines. The cooling tower is, however, not large enough to deal with both sets simultaneously. It was designed for a load of 400 KW. only, but a satisfactory vacuum can be obtained with a load of 550 KW. on the Parsons turbine.

View of 100-kw. Rope-Driven Set and 500-kw. Turbo-Generator.

The whole of the switchgear in the main generating station and in the sub-stations was supplied by Messrs. Cowans, Ltd., to the design of the borough electrical engineer, Mr. L. Andrews. One of the chief features of this gear is its simplicity. The controlling switches of the generators are mounted directly on an iron framework, supported on the face of a white glazed-brick wall. The cables from the respective generators are carried up the surface of the wall in pipes in such a manner that the entire arrangement is diagrammatic. The outer bus-bar is kept below the gallery. The inner bus-bars, of which there are two, are supported on corrugated porcelain insulators behind polished slate panels, upon the surface of which the ammeters are mounted. Separate panels are provided for each generator, and by removing the nuts from four studs, any panel may be removed for the purpose of examining the connections behind it. The main switches controlling all the Brush machines are of the water-break type, but a horn-break type of switch is used for controlling the turbo-alternator.

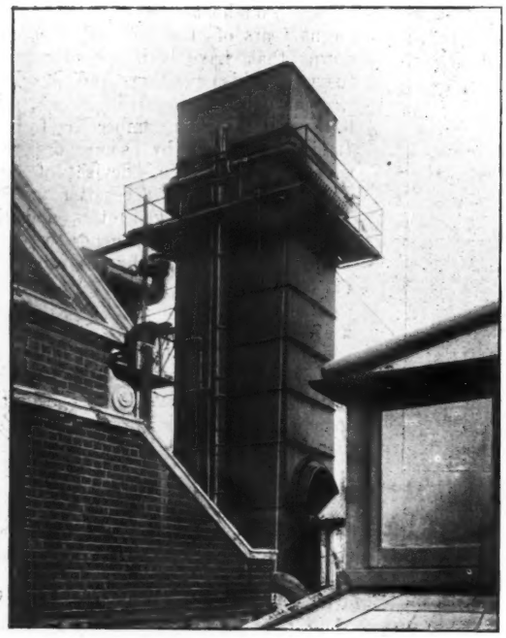
No fuses or excess current cut-outs are used between the generators and the main bus-bars. Fuses in this position Mr. Andrews considers to be an unnecessary and useless complication, and he believes that, if a record had been kept throughout the country during recent years of the number of break-downs that have been prevented by fuses in this position, and of those that have been caused by them, the latter would far outnumber the former. It is contended by some designers that no automatic device of any description is needed between modern alternating current generators and the bus-bars, as a faulty generator may be cut out of circuit by the attendant in charge. This would be true if something corresponding to the central zero ammeter in continuous current stations could be obtained to indicate which generator was failing, but it usually happens that, when one of the generators fails, all the ammeters go hard over to their maximum reading, and the attendant may have nothing to guide him as to which generator has failed. In the United States this difficulty has been overcome by using a return current relay to close a local circuit through an indicating lamp, fixed directly over the operating switch controlling the failing generator. At Hastings, instead of the delicate relay referred to, a small series transformer is inserted in the main circuit. This transformer is wound with two secondaries, and incandescent lamps, coloured red and green, are connected respectively across each secondary. The construction of the transformer is such that when the generator is doing useful work the green lamp is lighted; but should the generator fail and receive current from the bus-bars, the green lamp is extinguished and the red lamp lighted. There are no moving parts in connection with this most interesting and ingenious device, and consequently its behaviour is absolutely reliable. Unfortunately, it is not possible to enter into the details of the apparatus at present.



General View of Engine Room.

F

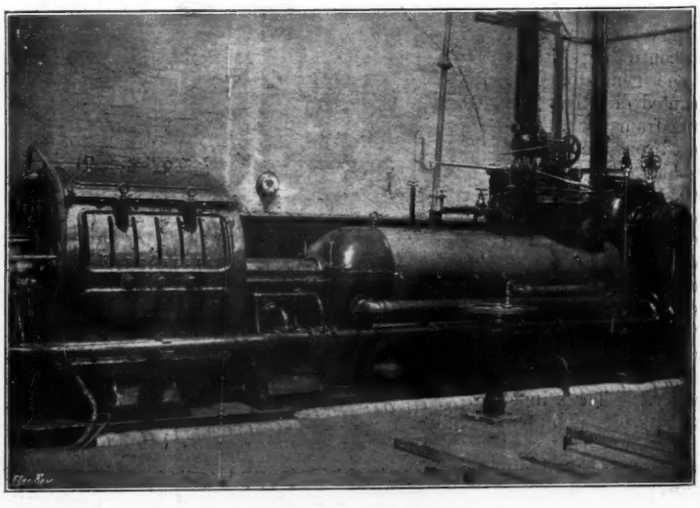
The area of supply at Hastings is one of the most difficult to contend with that could be imagined. It is very scattered, and consists of a number of small districts connected together by the one line of houses along the sea front. Low pressure direct-current supply is, therefore, practically out of the question. When the undertaking was purchased from the Hastings Electric Lighting Co., consumers were supplied at a pressure of 100 volts from transformers on their premises. During the past two or three years, this unsatisfactory and inefficient system of distribution has been abandoned, and all transformers are now arranged in sub-stations from half to three-quarters of a mile apart, while all consumers are supplied from low-pressure networks on the three-wire system, at a declared pressure of 200 volts. The area of supply is divided up into about a dozen small networks, and these are interconnected by fuses in the sub-stations only. By this means the effect of a bad low-pressure short circuit will be confined to the particular network in which it occurs.



Wheeler Cooling Tower on Roof of Station.

During the hours of light load, that is to say, from 11.30 p.m. to sunset the following day, the supply is maintained through the low pressure network, thus entirely avoiding the heavy losses usually connected with an alternating-current system, of charging the cables and exciting the transformers. Shortly before midnight one of the men from the generating station cycles round and opens the low-pressure switch in each sub-station between the secondary bus-bars of the transformers and the distributing bus-bars, thus entirely cutting off each sub-station on its low-pressure side. When all the sub-stations have been disconnected, the whole of the high-pressure system is shut down from and at the generating station, and the supply is maintained from a day-load set directly connected to one sub-station at the works. Quite apart from the very considerable saving effected by this arrangement, the advantages of being able to make the entire high-pressure system, including the switchboard, dead during the daytime are very considerable; amongst other things, the risk of accident to men working on the high pressure mains is greatly reduced. The sub-stations may be switched on again at any time at a moment's notice by means of the pilot wire between each sub-station and the generating station. These pilot wires are also used for indicating at the works the pressure in each sub-station, and notice of any failure in a sub-station is automatically signalled to the works through them.

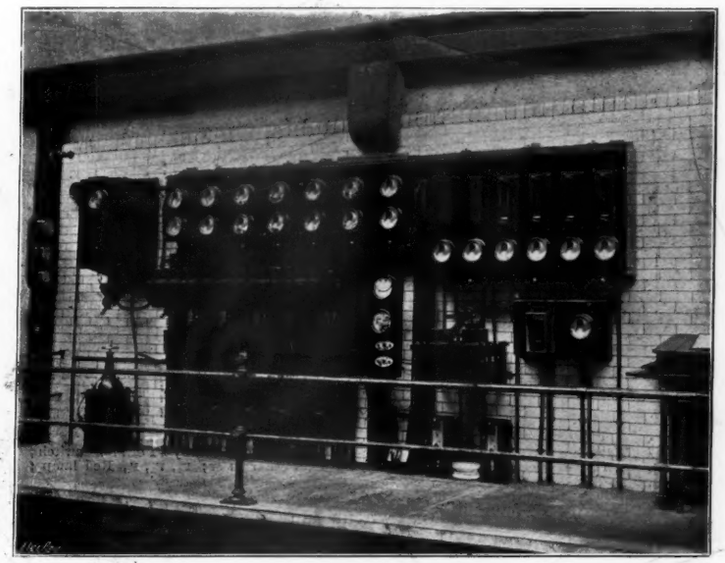
Each sub-station is fed by two independent high-pressure feeders in duplicate. The Hastings engineers have for years been attempting to protect these feeders in such a manner that, in the event of a short-circuit occurring on either feeder, the faulty feeder is automatically cut out of circuit and the supply maintained through the remaining healthy feeder. Although a considerable amount of success has resulted from these attempts in the past, the apparatus used for the purpose has been complicated and somewhat uncertain in its action. It is only within the past two or three months that the problem has been solved in a really simple and efficient manner. One of the troubles in the past has been that the healthy feeder had to provide the current necessary to operate the switch for cutting off the faulty feeder, in addition to taking over the whole of the load. This often damaged the healthy feeder, and caused the latter to break down as well. To get over this difficulty, many engineers have provided a duplicate feeder, but have left this disconnected, for use only in case of a failure on the working feeder; thus many thousands of pounds' worth of copper has been allowed to lie idle, which might have been profitably used for reducing the losses in the mains. By the arrangement now in use at Hastings, the liability of a failure on one feeder causing a breakdown on the other feeder has been entirely obviated, as an excessive current is prevented from flowing from one feeder to the other without any form of switching device whatever. For this purpose the feeders at the distributing station end are connected together through a choking coil, consisting of a few turns of insulated copper wire wound on an iron core. The supply of the load on the sub-station is tapped off from the centre of this winding. Under normal conditions the current being supplied to the sub-station is divided equally between the two feeders, and its tendency is to magnetise the iron in opposite directions; as the two magnetising forces just neutralise each other, there will be no magnetism in the core, and consequently no inductive drop in the windings. Should one of the feeders break down, current will tend to return towards the fault from the healthy feeder, but this current will circulate round the core of the discriminating choking coil in one direction only. As a consequence the core will at once become magnetised, and the counter electromotive force induced in the coil will entirely prevent an excessive current flowing from the healthy feeder to the faulty feeder.



Parsons 500-kw. Turbo-Alternator.

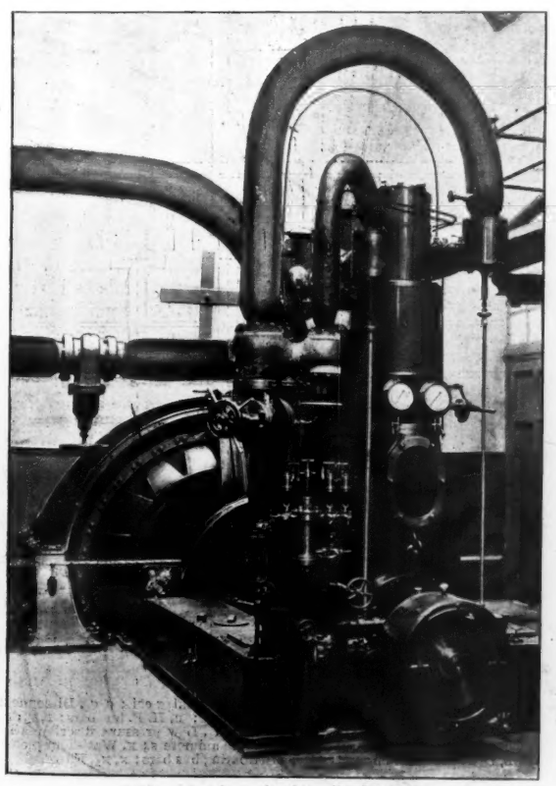
A very severe test of the above arrangement that has been repeatedly made, and always without failure, is the following: The feeders have been protected at the generating station end by a 150-ampere fuse on one feeder and a 10-ampere fuse on the other feeder. The feeder protected by the 150-ampere fuse has been short-circuited, thus blowing its fuse, and the supply has been maintained by the healthy feeder without blowing its 10-ampere fuse.

A discriminating choking coil large enough to carry a full load current of 50 amperes at 2,000 volts, without appreciable drop of pressure under normal conditions, and to choke the short-circuit current down to less than 25 amperes in the event of either of the feeders failing, is no larger than an ordinary 6-KW. transformer. Although the short-circuit may be left on without appreciably overloading the healthy feeder, it is, of course, desirable that it should be disconnected as soon as possible. This may be very simply effected by means of a discriminating transformer (see diagram of sub-station connections on p. 1074). The secondaries are in this case short-circuited by copper fuse wires, which support the weighted levers that serve, when released, to disconnect the respective feeders from the choking coil. The high-pressure primary of this transformer is connected between the duplicate feeders. It will be obvious that under normal conditions there will be no difference of potential between the terminals of this winding, but should a feeder fail, current will flow from the healthy feeder to the faulty feeder through the primary winding of this transformer, and the construction of the transformer is such that a heavy current will be induced only in *one* of the secondary windings, namely, that which controls the switch in circuit with the faulty feeder. The construction of this transformer is somewhat similar to that of the indicating device mentioned in connection with the main switchboard, and in this case also we must withhold the details for the present.

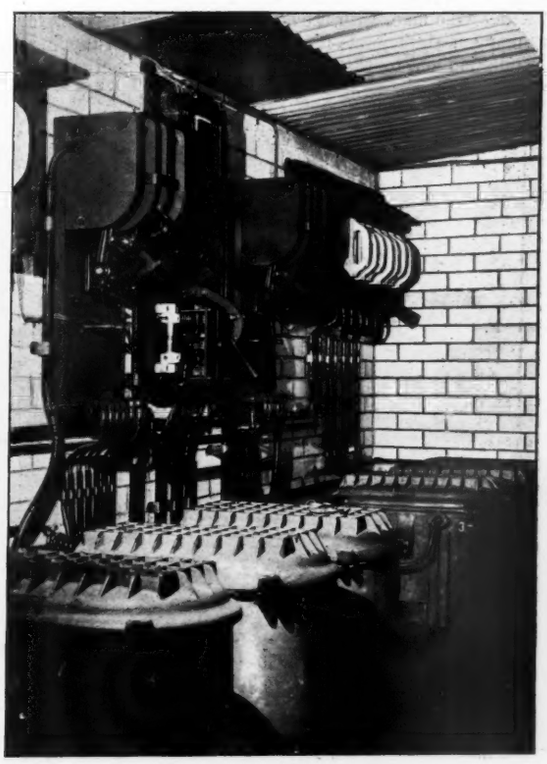


MAIN SWITCHBOARD.

All the connections between the bus-bars and the transformers are run in iron pipes, fixed to a glazed-brick wall. All unearthed high-pressure conductors are painted red, earthed high-pressure conductors black, and low-pressure conductors slate colour. An attempt has been made to arrange all the cables diagrammatically, so that the purpose of each connection can be seen at a glance.



BELLIS & MORDEY 200-KW. SET.



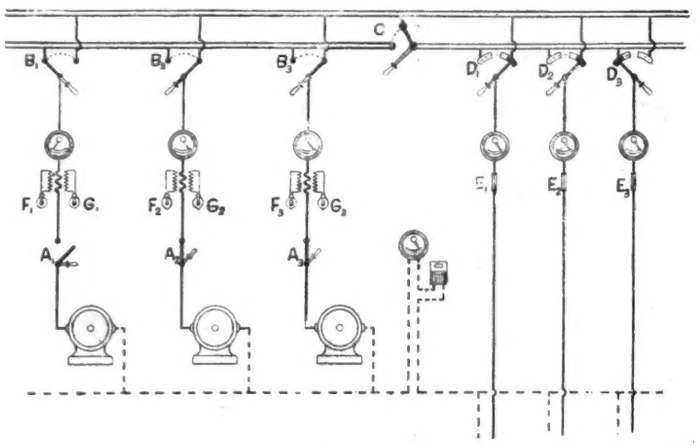
INTERIOR OF SUB-STATION.

Electricity meters are inserted between the transformer bus-bars and the distributing bus-bars; readings are taken of these meters in all the sub-stations every week and compared with the units generated. By this means a record is kept of the units lost in the high-pressure feeders and transformers.

Practically all the mains in use have been supplied by Messrs. Glover and Co. Some of these are high-pressure vulcanised rubber concentric cables drawn into iron pipes. These rubber cables have been in use for about 10 years, and appear to be in as good a condition now as when they were first laid. All mains that have been laid during the past two or three years consist of lead-covered diatrine paper cables; these are in most cases laid solid in wooden troughing, filled in with pitch. Bricks are in all cases laid over the troughing as a protection against picks. All the cables are concentric, the low-pressure cables being triple concentric.

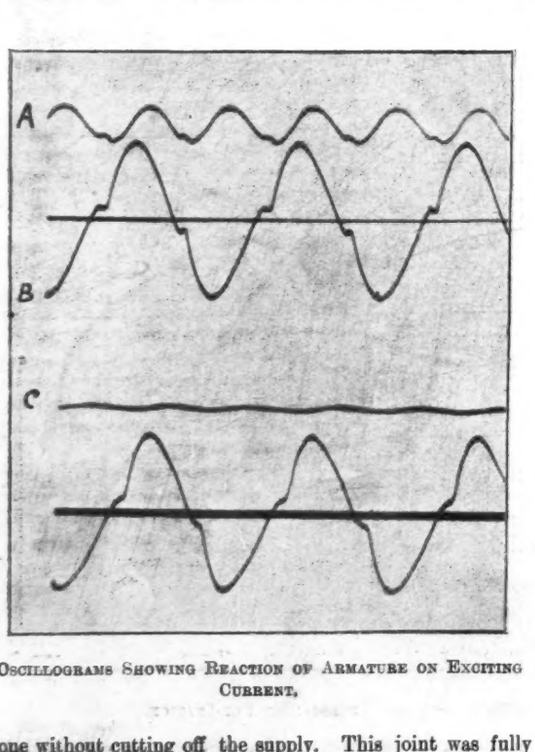
A simple form of joint, devised by Mr. J. Glass, mains foreman to the Corporation, is used for jointing concentric house services on to the mains. There are about 700 of these joints in use at Hastings, and none of them have ever failed. One man, with the help of a labourer, has completed as many as eight joints in a day, and the work of tapping an installation on to the outer and neutral conductors can be done without cutting off the supply. This joint was fully described in our issue of October 12th, 1900.

The test room, amongst other things, contains a Duddell oscillograph. This instrument is to an electrical engineer what an indicator is to a steam engineer; it enables numerous conditions to be investigated that could hardly be dealt with by any other means. During the past few months a large number of difficulties have been overcome by the aid of it. The following may be mentioned as an illustration of one investigation that was made some months ago:—A little difficulty was experienced by the contractors in making the Parsons turbo-alternator run satisfactorily in parallel with other machines. It was thought that this might be in some measure due to the reaction of the currents in the armature upon the field. To ascertain to what extent this reaction existed, an oscillogram was taken of the field current, the field being excited by batteries. It will be obvious that but for the armature reaction the field current curve would be a perfectly straight line, a certain distance away from the zero line, directly proportional to the exciting current. It will be seen by curve A (see oscillograms reproduced) that instead of being a straight line the current curve has a very perceptible wave in it, of double the frequency of the E.M.F. of the main generator, curve B. To overcome this armature reaction the contractors fitted between the armature and the pole-pieces a perforated copper cylinder. That this screens the field from the effect of the current in the armature is clearly shown by the exciting current curve C. This curve was taken under precisely the

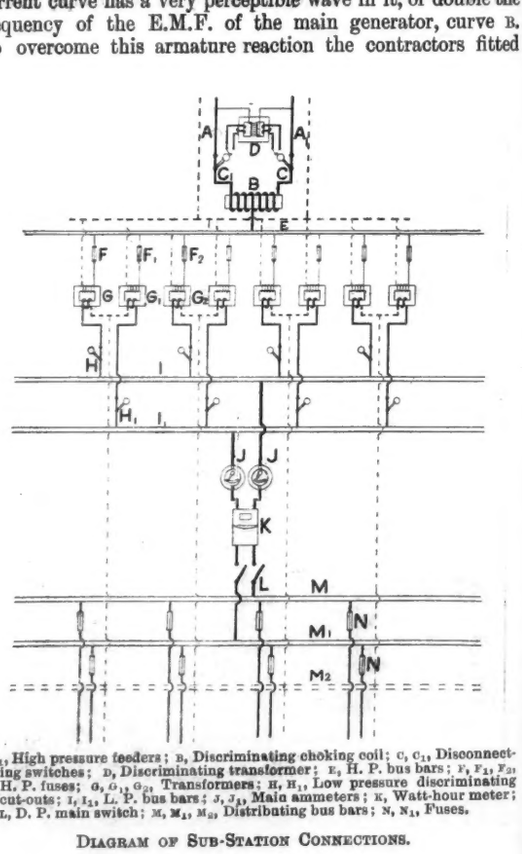


A_1, A_2, A_3, Water break switches; B_1, B_2, B_3, Two-way switches; C, Two-way water break switch; D_1, D_2, D_3, Two-way feeder switches; E_1, E_2, E_3, Feeder fuses; F_1, F_2, F_3, Red lamps; G_1, G_2, G_3, Green lamps.

Diagram of Main Switchboard Connections.



Oscillograms Showing Reaction of Armature on Exciting Current.



A, A_1, High pressure feeders; B, Discriminating choking coil; C, C_1, Disconnecting switches; D, Discriminating transformer; E, H. P. bus bars; F, F_1, F_2, H. P. fuses; G, G_1, G_2, Transformers; H, H_1, Low pressure discriminating cut-outs; I, I_1, L. P. bus bars; J, J_1, Main ammeters; K, Watt-hour meter; L, D. P. main switch; M, M_1, M_2, Distributing bus bars; N, N_1, Fuses.

Diagram of Sub-Station Connections.

same conditions as A, with the exception of the screening referred to.

Reference was made earlier in this article to the difficulty of obtaining an alternating current ammeter that would indicate the direction, as well as the magnitude, of the current passing through it. Another defect common to the ordinary alternating current ammeter is that it is impossible to obtain an accurate reading from it on the lower part of its scale. For use with alternating current generators, this is just the opposite to what is usually required. One of the chief uses of an ammeter is to indicate when the current is at zero, in order that a generator may be switched out of parallel at this point. Under existing conditions, the attendant is often unable to distinguish between a zero current and a generating or motoring current up to 25 per cent. of the full load, and, as a consequence, it often happens that in switching a large generator out of circuit, a very perceptible jump is caused in the lights. Mr. Andrews has recently turned his attention to constructing a central zero alternating-current ammeter with a very open scale at the low readings, and with a gradually closing scale towards the higher readings, with good promise of success.

On the invitation of the Sub-Electric Light Committee of the Corporation, a large party of engineers, some 100 in all, visited Hastings on Thursday last week for the purpose of inspecting the electricity works, and witnessing tests of a most crucial character carried out by Mr. Andrews with his new apparatus, as well as other highly interesting experiments.

The first test was one calculated to make a station engineer's blood run cold, viz., driving a nail into one of the high pressure feeders supplying the town! For the purpose of this test, an artificial load, consisting of a water resistance and lamps, equivalent to the full load of the Shepherd Street sub-station, was connected across the outers of the three-wire network at 400 volts at the sub-station; the current passing was shown by a Nalder ammeter, being 200 amperes during the test, and a Cardew voltmeter was connected with the high pressure bus-bars through a 20 : 1 transformer. At a given signal a nail was driven through one of the duplicate feeders supplying the sub-station; the party, at the latter point, saw the lamps fall in brightness, while the voltmeter showed a drop of pressure from 98 to 81 volts (representing an actual drop from about 1,960 to 1,620 volts) for a few seconds only; then the lamps regained their normal brilliancy, as the fuse blew at the generating station, and the apparatus in the sub-station cut out the faulty feeder altogether. The experiment was entirely successful, and fully demonstrated the reliability of the apparatus under actual working conditions. On their way from the sub-station to the Albany Hotel the visitors were driven in motor cars and brakes to the spot where the nail had been driven, so as to enable them to inspect this part of the experiment also.

An excellent lunch was served at the Albany Hotel, towards the end of which the Mayor proposed the health of the visitors, coupled with the name of Mr. Rider, who, in his reply, congratulated the town and Mr. Andrews on the success of the experiment. Mr. Raworth gave the toast of Councillor Bones, chairman of the Public Lighting Committee; in reply, Councillor Bones stated that the undertaking had been handicapped with a heavy capital outlay, dear coal and scanty water, but was well laid out and equipped. He modestly attributed much of the success attained to his predecessor, Dr. Allfrey, who was chairman of the Committee from 1897 until this year. They regretted the impending loss of Mr. Andrews, but were retaining him as consulting engineer. Mr. Fawcus gave the health of Mr. Andrews, who replied briefly.

The party then proceeded to the power station, where one of the Belliss-Brush generators was running on the town load; the green lamp of the small series transformer, inserted in circuit with this generator, was lighted, thus indicating that the generator was supplying current.

First, the turbo-alternator was switched into parallel with the Belliss-Brush generator referred to above, using for this purpose an Everett-Edgcumbe rotary synchroniser. Immediately after the generators were switched into parallel, the load was transferred from the Belliss-Brush set to the Parsons set, and steam was entirely shut off the former. As the load on the Belliss-Brush set fell to zero, the green lamp died out and the red lamp began to glow, and by increasing the motoring current, the green lamp was entirely extinguished and the red lamp glowed alone, thus indicating to the attendant which generator was doing no work.

The load was again transferred to the Belliss-Brush set, and the field winding of this generator was then short-circuited. As the field died down, the current in the main circuit, indicated by the ordinary ammeters of both generators, steadily increased. The glowing of the red lamp indicated the faulty machine, and this was automatically cut out of circuit when the motoring current reached a predetermined limit.

Next, the experiment performed at the sub-station was repeated; it was shown that the duplicate feeders could not be protected by fuses alone, but that Mr. Andrews's device immediately cut out the faulty feeder, even when the sound one was protected by a very light fuse.

Another experiment showed that, if the discriminating transformer was omitted, there was a considerable drop of pressure in the supply so long as the shorted line was connected to the system, but the supply was not interrupted, nor was the healthy main damaged.

The "horn" type of circuit-breaker was used in all the foregoing experiments. It is generally thought that the heated air carries the arc up the horns until its length is so great that the pressure is insufficient to maintain it; it was, however, urged that this has very little to do with it, and one of the circuit-breakers was constructed with horizontal horns, to demonstrate that the extinction of the arc is due to magnetic repulsion. It was reasoned that, if this were so, the horizontal horns should interrupt the circuit more effectually and quickly than horns of the usual shape, and this certainly appeared to be the case. On examining them it was seen that the horizontal horns were evenly pitted along their entire length, whereas an inspection of the ordinary horns showed that an arc was maintained from the extreme points long enough to fuse them badly.

We would suggest that the experiment should be tried with the apparatus inverted, or on its side; if the new theory is correct—and it is certain that the repulsion referred to does exist—the break should be almost equally effective in these positions.

Other high-pressure fuses were shown in operation, short-circuiting the Mordey alternator at 2,000 volts. These included Messrs. Ferranti's oil-break fuse, Mr. G. W. Partridge's sparklet fuse, and a new device of Messrs. Cowans, Ltd., all of which were perfectly successful in at once removing the short circuit.

The Carboné arc lamp was exhibited in operation by its inventors; it is claimed that this lamp constitutes a new departure, and is of extreme simplicity.

The Corporation of Hastings, Mr. Andrews and his assistants are to be congratulated upon the complete success of the whole of the demonstrations, which were followed with the keenest interest by the visitors.

TELEGRAPH AND TELEPHONE NOTES.

Brighton Telephones.—The T.C. last week adopted the Telephone Committee's report, of which we have already given a summary. The Corporation will at once advertise for a manager and the necessary staff to act under Mr. Bennett.

Up to the present about 1,000 telephones have been asked for (exclusive of Corporation requirements):—

	Limited.	Unlimited.	Total.
Municipal Borough	125	618	743
Borough of Hove	27	124	151
Portslade	1	5	6
Southwick	1	0	1
Shoreham	2	5	7
Burgess Hill	0	2	2
Hassocks	0	4	4
Steyning	0	3	3
Rottingdean	0	10	10
Totals..	156	771	927

Lighthouse Communication. — In the House of Commons on the 17th inst., Mr. G. Balfour stated that during the present year electrical communication had been established between two lighthouses and the shore, but was not available for private messages. Further progress would be made with the work during the present financial year. The whole matter had been somewhat delayed by the consideration of questions surrounding the development of wireless telegraphy, a subject which was engaging the earnest attention of the Government.

Portuguese Telephones.—The Anglo-Portuguese Telephone Co. are relaying their telephone system throughout Lisbon and Oporto, the underground conduits for the same having been supplied and laid under the supervision of Messrs. Rowland Carr & Co.

Wireless Telegraphy.— The *Times* of Monday last said: "We understand that an official message has been transmitted by Signor Marconi's wireless telegraph from Lord Minto to the King, and that Signor Marconi has himself transmitted a message to Lord Knollys for the King, and has sent another message to the King of Italy. We have received by post from Poldhu, the receiving station in Cornwall of the Marconi system, the following wireless telegram from our special correspondent at Glace Bay.—Being present at its transmission in Signor Marconi's Canadian station, I have the honour to send through the *Times* the inventor's first wireless trans-Atlantic message of greeting to England and Italy."

CONTRACTS OPEN AND CLOSED.

OPEN.

Barrow.—January 5th. Two 250-KW. steam generators, switchboards and piping. See "Official Notices" December 5th.

Bristol.—January 6th. Surface condensers for Avonbank station. See "Official Notices" December 19th.

Bulawayo.—February 26th, 1903. Establishment and working of an electric tramway. See "Official Notices" Nov. 21st.

Canterbury.—January 1st. Tell-tales, clocks and bells. See "Official Notices" December 19th.

Colchester.—January 17th. Wiring, &c., for Essex and Colchester Hospital. See "Official Notices" to-day.

Devonport.—December 29th. Overhead equipment for Corporation tramways. See "Official Notices" December 5th.

France.—January 1st. The Prefectural authorities of the department of Calvados are inviting projects until January 1st, 1903, for the construction and working of an electric tramway, for the transport of passengers and goods between Trouville and Honfleur, a distance of about 10 miles. Particulars may be obtained from, and proposals are to be sent to, La Prefecture de Calvados, Caen.

Glasgow.—January 5th. 100 electric motor equipments and spare parts. See "Official Notices" December 12th.

Lowestoft.—January 7th. Motor cars, trucks, motors, and equipments, and track sweeping and watering car. See "Official Notices" December 12th.

Oldham.—December 30th. Cables, joint boxes, &c. See "Official Notices" December 19th.

Partick.—January 6th. Arc lamp columns, arc lamps, mains, &c. See "Official Notices" December 19th.

Southend.—Jan. 6th. Wiring municipal buildings, &c., for electric light. See "Official Notices" to-day.

Stalybridge.—January 5th. Cables, telephone and test wires, high and low tension switchboards for main and sub-stations. See "Official Notices" December 12th.

Stepney.—January 15th. 500-KW. steam dynamo. See "Official Notices" December 19th.

Stoke-upon-Trent. — January 14th. Destructor, boilers, pumps, conveyor, economiser, steam dynamos, balancer, boosters, switchboard, battery, mains, &c., crane, and workshop machinery. See "Official Notices" December 12th.

Sunderland.—January 2nd. Lancashire boiler, with fittings, &c. See "Official Notices" December 5th.

Swansea.—January 8th. Wiring and fittings for new harbour offices. See "Official Notices" December 19th.

Swindon.—December 29th. Wiring of Town Hall. See "Official Notices" December 12th.

Wallasey.—January 15th. Steam dynamo, Lancashire boiler, condensing plant and cooling tower. See "Official Notices" December 5th.

Wigan.—December 29th. Switchboard extensions, and supply of cable. See "Official Notices" December 12th.

Wellington, N.Z.—January 21st. Supply and installation of all material, including power house equipment, overhead work, track work, feeders, tramcars, &c., for tramways. See "Official Notices" December 12th.

CLOSED.

Broompark.—The lighting of Aldin Grange and Outon Style has been let to Messrs. Reid & Ferens, of Sunderland and Newcastle-on-Tyne.

Chester.—The T.C. has accepted the tender of Messrs. Mather & Platt, Ltd., of Salford, for the supply of an engine and dynamo for the electric light station, at £2,570.

Falkirk.—The T.C. has placed the contract for the supply meters in connection with the electric lighting with Messrs. Chamberlain & Hookham, of Birmingham. The meters will be ordered as required.

Glasgow.—The Corporation has accepted the estimate of the Standard Iron Co., Ltd., for 12 cast-iron network manholes, £87, for the electricity works.

Horsham.—We understand that Messrs. Reavell & Co., Ltd., of Ipswich, have sub-let a contract for water-tube boilers, &c., to Messrs. T. Sugden, Ltd., of 180, Fleet Street, E.C.

Huddersfield.—The following contracts have been duly executed for the Corporation:—St. Helens Cable Co. for cable, Fuller Wenström Co. for motors, British Westinghouse Co. for transformers, and W. T. Glover & Co. for cable.

Ipswich. — The T.C. on December 17th accepted the following tenders in connection with the electric tramways:—The Electrical Co., Ltd., for switchboard, at £2,833; the British Electric Equipment Co., Ltd., London, for overhead equipment, at £9,301.

Luton.—The Council has placed an order for distributing mains with the St. Helens Cable Co., Ltd.

Mansfield.—The Town Council on Friday accepted the tender of the Mansfield Engineering Co. for the wiring of the new electricity works at £303 14s. 2d.

FORTHCOMING EVENTS.

Saturday December 27th.—At 3 p.m. Royal Institution. Lecture I., by Prof. H. S. Hele-Shaw, F.R.S., "On Locomotion: On the Earth—Through the water—In the air."

Tuesday, December 30th.—At 3 p.m. Royal Institution. Lecture II., by Prof. H. S. Hele-Shaw, "On Locomotion: On the Earth—Through the Water—In the Air."

Thursday, January 1st.—At 8 30 p.m. Röntgen Society. Meeting at 20, Hanover Square. Paper by Dr. G. M. Lowe on "X Ray Work in Private Practice."

Friday, January 2nd.—At 8 p.m. Institution of Junior Engineers, Westminster Palace Hotel. Paper on "Modern Marine Boilers: a Consideration of the Relative Values of Different Types," by H. M. Rounthwaite, M.I.M.E., honorary member.

EVIL WORKSHOP CONDITIONS

An evil which we are not inclined to think general has been exposed by Mr. T. Good in the *Engineering Magazine*. This evil is that of bribery or blackmail, which it is asserted prevails extensively in the matter of underground commissions and payments. Shop managers appoint foremen for purposes of their own, and foremen in turn appoint charge hands and others for similar reasons, quite distinct from the welfare of the business. At least 90 per cent. of shop promotions that have come under Mr. Good's notice have

been bestowed upon other than the best men. Where such conditions prevail there is not much encouragement for the latter. The man who gets on best, we are told, is he who attends the same church or the same pub. as his foreman. Men who are managers' favourities are allowed to charge for hours they have never worked. Men have even drawn full wages whilst earning money elsewhere, whereas good men have been dismissed for losing two quarters in one week. Trading by managers and foremen is a system that often makes for dishonesty; the workman who patronises his foreman's shop is the man to be kept on when better men are dismissed, and many managers and foremen are said to draw more money in commissions from shopkeepers than they draw in salaries from their employers. Moneylending is another evil, and it is easy to understand that the borrowers are likely to be the drunken incapables rather than the sober men.

Again, our author considers it utterly wrong to give preference to young men, who are really less valuable than the more mature men, who are less likely to make errors leading to accident. The author has seen the youth of 20 called in, and the man of 40, with a family to support, turned adrift.

One great cause of all the trouble is the wide gulf between employés and employed. This opens up a very difficult point. It would be waste of time to discuss this, because it is the inevitable result of the Limited Liability Act and the abolition of the small, or even large private employer, who used to know every one of his men by name, or a very large majority of them.

All the evils enumerated do, no doubt, tend to the discouragement of the good man, but it must not be forgotten that the trades unions do all they can to discourage good men, and they do all they can to discourage men from rising.

Let us cite an example. Motor cases of steel cannot be made in England in competition with America, because in England they are not allowed to be made by men earning less than 40s. per week. In America they are moulded by improved labourers, who receive about 26s. Result—not only does the English moulder lose the trade, but the English labourer does not get it. If he were allowed to do the work, and earn 25s. in place of 22s. on mere labourer's work, the trade would be possible in England. The action of the trades unions is on a par with a demand by, shall we say, the surgeons, that no man shall have a tooth drawn for less than 12 guineas, because it is something of a surgical operation. Not long ago we watched three men bending iron bars in a press. They put one bar into a furnace that would hold six or eight. When it was hot, for which they waited very patiently, they took it out and bent it This done they heated another, and so went on. Now, these men were either knaves or fools—knaves if they knew better, fools if they had not sense to think out the problem of keeping a succession of bars passing through the furnace. They bent about 10 bars in a day. Three men could easily have bent over 100.

We watched another man on a milling machine. He ran four cuts over a surface to remove ½ in., and was surprised to learn that he could do it with single cut at slightly less feed with less damage to the tool. He simply did not know, and was probably intelligent enough to learn. But we attribute the lamentable quality of so many workmen very largely to the employers. For years the British engineering employer has advertised for the dirtiest of his fellow creatures as workmen.

If a man has tried to be clean, he has in time been thoroughly beaten by the artillery of dirt at the command of the employer. In due time the trade of machinist has become accepted as only fit for a dirty fellow. Did not Dr. Johnson define a mechanic as a low, mean fellow?—*Vide* Johnson's Dictionary. Men who in America are mechanics become clerks here because they are gifted with the vice of cleanliness. The mechanical trades have taken in the dirty ones, and the employer has got his dirty men, and it will require time to alter things. In America we hear that there is a considerable difficulty in getting men to keep clean, so that it is not all the fault of employers. Cleanliness in dirty surroundings requires effort to maintain. Employers have done nothing so far to help.

To revert to the question of favouritism. We affirm that much harm has arisen from the Limited Liability Acts. Capital is wanted in an undertaking, and is obtained in certain directions under conditions which entail employment for certain men who are absolutely ignorant of the smallest detail of the work they are to direct. Great undertakings like railways, for example, are not found in the hands of men of no experience in America. Here a ducal coronet or some similar gew-gaw is a sufficient title to a chairmanship, and there is not an English railway that is really managed to the best advantage; we believe there is no titled railway director who can claim to have had a practical training in any form of railway work. We have no fault to find with titled men as such, but we do affirm that their presence as managers of great undertakings is bad for such undertakings in the majority of cases, because there are always so many hangers-on to such who stop the advancement of better men.

Possibly at one time British trade could afford to load itself up in many ways. To-day such luxuries cannot be afforded, and both the workmen and those who have replaced the old employers should, and must, learn to divest their business methods of expensive trimmings.

If British trade is about holding its own to-day, what a wide margin it possesses on the right side! Get rid of this margin of waste and incompetence, and foreign competition will be of small significance. But can we hope to effect much improvement while, the action of trades unions is what it is at present, and while on the other hand, employers are so thoroughly ignorant of the processes they are supposed to control?

NOTES.

Christmas Greeting. — The Electrical Review heartily wishes all of its readers and other friends a right merry Christmas. The extreme pressure under which most electrical men have to work in these times of progress, renders the holidays a very welcome break. Let us hope that all will return to their respective callings with renewed vigour.

May the year 1903 bring a full measure of prosperity to the entire electrical profession and industry!

The Patent Exploitation, Ltd., v. Siemens Bros. and Co., Ltd.—Lords Justices Vaughan Williams, Stirling and Cozens-Hardy sitting in the Court of Appeal on Saturday, gave judgment in this case. This was the plaintiffs' appeal from a decision of Mr. Justice Buckley, who had dismissed an action brought to restrain infringement of a patent for improvements in galvanic batteries. The learned judge had decided that there was no novelty in the invention claimed, and that the claim was too wide and the patent invalid.

Lord Justice Williams, in giving judgment, said there could be no doubt that the plaintiffs' battery had achieved a great commercial success and met a want not hitherto satisfied. It was said by the defendants that the plaintiffs' specifications wanted the characteristic novelty necessary to support letters patent, and even if the plaintiffs' battery had some new features, they were not such as to constitute proper subject matter for a grant of letters patent. His Lordship dealt with the specification in some detail, and said he had come to the conclusion that the plaintiffs' patent properly construed had novelty and subject matter, and had not been anticipated. He, therefore, thought the appeal should be allowed.

Lord Justice Stirling and Lord Justice Cozens-Hardy were of the same opinion, and the appeal was therefore allowed with costs.

The case was argued by Mr. Astbury, K.C., Mr. A. B. Shaw for the plaintiffs, and by Mr. A. J. Walter and Mr. G. Hume for the defendants.

Large Valves for High-Pressure Steam.—A paper was read on December 12th before the North-East Coast Institution of Engineers and Shipbuilders, on the subject of large valves for high-pressure steam. The author, J. Hamilton Gibson, appears to be familiar with the subject. He dealt first with experiments, made in conjunction with Mr. Bevis, on double-beat valves of equilibrium type, which, as all know, are in a chronic state of leakage. When shut off, these valves will often pass steam enough to drive a ship at half speed. The trouble is that two valves in one piece cannot be made to make joint on two seatings at one time. The valve casing expands and twists, and only by great force can a valve be closed tight, an operation which often means a heavy stress on the parts. In the great ocean liners the main stop valve is worked by a separate steam engine and worm gear.

The author next discusses the various means tried for balancing a large valve. The common result is that when a ship is standing the valves leak. The author's remedy, to be brief, consists in forming one seat of a thin flexible plate, upon which the valve seats itself perhaps $\frac{1}{16}$ in. or a $\frac{1}{32}$ in. before the other valve comes to seat. An elasticity is thus introduced that overcomes the distortion of the valve body and any twist of the valve itself. The flexible discs are of hard rolled bronze, and it is so arranged that there shall be a small differential pressure tending to keep the solid valve to its seat, which difference alone needs to be overcome when opening the valve. At first the discs were made with a curled edge for greater stiffness. Here, says the author, were we evolving a flexible valve, and tied fast to the idea of stiffness all the time! However, they perceived their own inconsistency, and finally used simple flat discs, which proved perfectly satisfactory. The valve carries a raised lip. The rolling skin should be left on the discs, for it helps to maintain their elasticity for a longer time. What ruins most valves is the cutting action of the steam between closed faces when a leak does commence. The lesson is—avoid a small leak and a large one will not grow up. A mere whisper of steam soon grows into a roar. As regards ordinary stop valves, closed against pressure, the load comes on only when closed, not just before closing. It comes on when, the valve being closed, it is necessary to compress its spindle to keep it tight.

With the flexible seating, as soon as the valve approaches the seat, and the rush of steam becomes acute round the edge of the discs, this bends and automatically effects final closure. It is more difficult to open such a valve than it is to close it. The discs may be thin, from 16 to 22 S.W.G. Finally the author suggests that valves are too large. Why, he asks, should a range of 12-in. pipe have 12-in. stop valves, when a smaller valve will serve? The friction of steam in a pipe is a matter of pipe length, but a constricted short piece does not do much harm. How many valves are ever opened $\frac{1}{4}$ *d*, which is necessary to give a passage as large as the pipe? Usually, three or four turns will represent a "full open" valve, though nine turns would be necessary to give an opening of $\frac{1}{4}$ *d*. Thus with, say, 3½ turns on the boiler stop valves, and half-open intermediate valves, the engines are going full speed with the main regulating valves one-third open, and no greater speed results from wider opening. Again, separators in the main steam-pipe have orifices one-fourth the pipe area and so on. The argument is, why not make all valves one-half the pipe area, so that a 12-in. pipe would have 8½-in. valves, and a 6-in. pipe 4-in. valves or thereabout?

The author appears to us to be right. Many years ago, Mr. Richard Peacock of the M. S. & L. Railway put a blank flange into

a locomotive steam-pipe, and he tested the locomotive with holes of various sizes drilled through the flange. No difference was found in the running until the hole was as small as 1¼ in., or about one-twelfth of the pipe area. Generally in respect of pipe sizes these are probably made too large, and it is tolerably certain that enormous sums are wasted on valves. Not only is the useless ring main idea not yet scotched—it must surely have been a valve maker who invented the ring main—but valves are too clumsy. We recommend all engineers to read this paper of Mr. Gibson's. As he says, "It is well known that a short obstruction in a line of pipe has little effect on the flow, especially of steam. Why not deliberately apply this knowledge to stop valves?" Why not, indeed?

London County Council.—The General Purposes Committee stated at a meeting of the Council on Tuesday last week, that an offer had been made some time ago to present to the Council an electric ambulance for the conveyance of persons injured in the streets.

Purchase of Company Undertakings.—The Parliamentary Committee presented a report relating to the Bill which the Council recently authorised to be prepared for the purchase of electric supply undertakings. In the preparation of the Bill the Council gave the Committee some discretionary power as to its form, and they now directed attention to the proposal contained in the second part of (2) which was not included in the Bill which failed to pass last session. The powers sought to be conferred by the Bill which the Council decided to approve, may be summarised as follow:—

1. To enable local authorities in combination to purchase electric lighting undertakings.
2. To enable the Council in cases where local authorities do not desire themselves to exercise their powers of purchase under the Bill, to purchase a company's undertaking with the consent of the authorities concerned, and to require local authorities purchasing in combination to sell to any of the local authorities concerned, at their request, part or parts of the purchased undertaking within their several districts.
3. To enable any undertaking supplying electrical energy in bulk to which, or to the whole of which, the purchase provisions of the Electric Lighting Acts do not apply, to be subject to purchase under the Electric Lighting Acts, providing that in case of any existing company supplying in bulk only, the purchase price shall be determined in accordance with provisions of the Lands Clauses Acts.
4. To authorise the Council to supply by agreement electrical energy to local authorities.

Conversion of the North Metropolitan Lines.—The report of the Highways Committee announced that notice had been given to the North Metropolitan Tramways Co. of the intention of the Council to put in force the provisions of the lease relating to the adoption of electric traction for the working of the leased lines. Preliminary plans had been prepared by the Council's officers indicating the characteristics of the routes to be dealt with in order to ascertain what system or systems it would be advisable to adopt, and the Committee stated that they were in communication with the company and with certain of the local authorities in regard to the matter. With a view to submitting proposals for the reconstruction of the lines, the officers had been instructed to proceed with the preparation of detailed plans and with the making of the necessary surveys on certain lines. The engineer had represented that he would be unable with his present staff to cope with the large amount of additional work, and the Committee, therefore, considered that the best plan would be to employ temporarily a further number of assistants in the engineer's department. A preliminary capital vote of £4,000 was sanctioned for the preparation of plans and additional assistance.

More Rail Contracts.—The Highways Committee reminded the meeting of the authority given to invite and accept tenders for the supply of 2,245 tons of track rails, 1,470 tons of slot rails, and 580 tons of conductor rails for the reconstruction of the lines between New Cross and Greenwich, &c. A further quantity of 520 tons of track rails and 125 tons of conductor tees were required for the New Cross, Clapham and Camberwell car sheds, and the Committee had given directions that persons applying for forms of tender should be asked to quote prices for the increased quantity of each kind of material.

High Voltage Transmission.—We read in the *Electrical World* that, at the September meeting of the American Institute of Electrical Engineers, a committee was appointed consisting of Ralph D. Mershon, chairman, and Messrs. F. O. Blackwell, C. C. Chesney, P. M. Lincoln and R. S. Masson, for the purpose of collecting data respecting present practice in electric transmission at high voltage and of presenting a report which will indicate the successful methods which are now in operation, in such form as to be of immediate value to electrical engineers. It is within the scope of the committee to secure data upon line construction, insulators, pins and the like, and the conditions of operation at different voltages and under different climatic conditions; to investigate methods of testing insulators and to indicate the method or methods which in its judgment are superior. Also to ascertain the methods employed for voltage regulation, the conditions attendant upon the switching of high-pressure circuits and to collect data respecting lightning and static disturbances and the use of grounded protective wires.

Appointment Vacant.—A tramway manager at Rotherham at £150. See "Official Notices" to-day.

Society of Arts.—The Council, acting on the recommendation of the judges appointed by it—Sir William H. Preece, K.C.B., F.R.S., Mr. Robert Kaye Gray and Mr. Alexander Siemens—has awarded the prize of £50, together with a silver medal, offered for an essay on "Existing Laws, By-Laws and Regulations Relating to Protection from Fire, with Criticisms and Suggestions," to Mr. T. Brice Phillips, sanitary inspector to the Uckfield Rural District Council. A prize of £10 with a bronze medal has been awarded to Mr. George H. Paul, and a similar prize to Mr. W. Craig Henderson, D.Sc.

Physical Society.—At a meeting held on December 12th, Mr. S. Lupton, Vice-President, in the chair, Mr. S. W. J. Smith exhibited and described "A Portable Capillary Electrometer." This instrument is a modification of the form of capillary electrometer which consists of two wide tubes joined by a cylindrical capillary tube, which may be horizontal or inclined. The apparatus contains mercury and sulphuric acid of about maximum conductivity suitably distributed in the tubes. A spring key is commonly employed with such an instrument, and keeps the two platinum terminals at the same potential unless the spring is depressed. When the spring is depressed, the terminals are put in contact with the two points the potentials of which are to be tested for equality. In the instrument shown by the author the two wide tubes are sealed at the top to prevent evaporation of the sulphuric acid. The wide tubes are also joined near the top by another tube which allows free motion of the liquids within the apparatus. With this arrangement the instrument is made air-tight, and can, if desired, be made air-free by exhaustion of the apparatus before sealing. The distribution of the mercury can be altered most easily by means of a third cross-piece provided with a tap. To prevent the platinum wires forming the electrodes being wetted by the acid, if the apparatus should accidentally, or during transit, be laid on its side or turned upside down, the lower ends of the tubes may be slightly constricted above the ends of the platinum terminals. If the terminals consist of amalgamated platinum foil the constriction is unnecessary. If a spring key is made of brass the contacts frequently become unsatisfactory through surface tarnishing, and if to avoid this the bearing surfaces are made of platinum, the key may be subject to thermo-electric effects. Such a key cannot conveniently be fastened on the same stand as the rest of the instrument, for, unless the stand and the support on which it rests are very rigid, the pressure necessary to depress the spring produces sufficient movement of the meniscus, during the act of depression, to render the detection of minute changes of surface-tension impossible. These difficulties are overcome by using a key consisting of a U-tube closed at one end, communicating at the other with a pneumatic pressure ball and containing mercury in the bend. Three platinum wires are fused into the tube, so that by squeezing the ball the same change of contacts is produced as by pressing the lever of an ordinary spring key. This form of key can be extended so that a slight pressure applied to the ball makes it work as an ordinary electrometer-key, and greater pressure reverses the contacts between the terminals and the points under investigation. With such an arrangement the sensitiveness of the instrument is doubled, and by using a microscope magnifying 50 diameters a potential difference of $\frac{1}{10000}$th volt can be detected without difficulty. The instrument, used as a surface-tension galvanometer, is more convenient than an ordinary galvanometer with a magnetic system because there is no suspension, no lamp and scale, and practically no levelling.

Dr. R. T. Glazebrook congratulated the author, and said that workers with the capillary electrometer would appreciate the improvements introduced. He said that the author had given the minimum E.M.F. which the instrument could detect, and asked what was the maximum E.M.F. which could be safely applied. He referred to the advantages of the mercury keys exhibited, and remarked that, by their use, many difficulties were obviated.

Dr. Lehfeldt said the mercury keys were improvements on those used by Prof. Onnes. In these keys the contacts were changed by the motion of mercury brought about by tilting. The tubes containing the mercury were exhausted to prevent oxidation.

Mr. Smith, in reply to Dr. Glazebrook, said that the maximum E.M.F. should not exceed half a volt.

Electricity, Petroleum, and Acetylene for Lighthouses in Foggy Weather.—We mentioned some time ago that an acetylene light had been erected at Altenbruch, on the Elbe, as to which complaints were made by sailors that it did not penetrate so well through mist and fog as did a petroleum light close by. As it is well known that the best fog-penetrating light is one of a reddish tint, the suggestion has been offered that the acetylene light should be tinted red by suitable glasses. But a red light cannot be made by coloured glasses: red glass does not create red light, it only acts as a filter, straining out (roughly speaking) all the rays which are not red in the original flame, and passing only the red residue. Now, since every source of industrial light is more or less white in tone, it contains rays of every wave length; and therefore when a coloured glass is put in front of it, every component of the light is wasted by reflection back into the lantern, by absorption into the body of the glass, and by ultimate manifestation as heat, except the aforesaid red. Accordingly, however fearfully and wonderfully the glasses may be constructed, the issuing light is only equal in volume to the red rays naturally produced in the flame. Monochromatic flames of various colours are known to our chemists—a flame containing the vapour of calcium or strontium is red, more or less pure; but, unfortunately, these lights have not proved capable of employment on such an enormous scale as is necessary in a lighthouse. Hence, as we cannot at present manufacture directly a pure red light on a commercial scale, it follows that the best source of illumination for foggy weather is one originally as rich as possible in red rays among its other constituents; distinguishing colour apart, there is no object in putting a red glass before it with the idea of increasing its penetrating

power—that power is not increased by such treatment. We really want to know which light emits the highest candle-power, measured in red rays only, for the same amount of money. In practice, as we have said already, the whole question is complicated by the desire of mariners to have here a white, there a green, and there a red light, although the former are more extravagant in foggy weather, and the first tends to become reddish when shining through atmospheric moisture. Again, when powerful long-distance lights are required, a rather intricate arrangement of reflectors and refractors is rendered necessary; and not only do these apparatus become more expensive in a higher ratio than that at which their diameter grows, but also the difficulties of making and keeping them optically perfect increases with the size of the flame. Actually, then, in the construction of a lighthouse to give a powerful beam in all kinds of weather, two opposing factors have to be reconciled as well as may be: the lantern itself asks for a minute extremely intense source of light; the fog demands a large, relatively low-temperature light of small intensity per unit of area.

Engineering Standardisation.—It is stated in the newspaper Press that the Standardisation Committee, which began its operations in June, 1901, has now reached some very definite results in its labours, and has agreed upon a series of recommendations in several trades using iron and steel, which will shortly be published. It is hoped that these recommendations, possessing the authority of so representative a body of practical men, will enable the great spending departments of the Government to effect a saving which is reckoned by millions annually, and will be a still more financially important factor outside of Government work by enabling British producers to meet the competition of Germany and the United States. The movement was unofficial in its origin, but the Government departments have been in entire sympathy with the work of the committees, and have co-operated in their labours. At the annual dinner of the Iron and Steel Institute, Mr. Arnold-Forster, M.P. (Under Secretary to the Admiralty), called attention to the enormous importance of standardisation and uniformity of tests, and said that England was far behind the Continental nations. Shortly afterwards a deputation had a private interview with the Prime Minister, and received from him assurances of the support of the Government. The movement owes its existence to a resolution of the Council of the Institution of Civil Engineers in favour of the appointment of a committee "to consider the advisability of standardising the various kinds of iron and steel sections, and if found advisable, then to consider and report as to the steps which should be taken to carry such standardisation into practice." The Iron and Steel Institute and the Institutions of Mechanical Engineers, Naval Architects, and Electrical Engineers were asked to co-operate, and a committee was appointed to undertake the work. This committee, which became known as the Main Committee, consisted of seven representatives of the Civil Engineers, and two each of the other societies co-operating. The work has grown as the committees have proceeded, and the original reference has been enlarged so as to include committees on the standardisation of tests and specifications for iron and steel material used in the construction of ships and their machinery (presided over by Mr. A. Denny), a locomotives committee (Sir Douglas Fox, chairman), and electrical plant, with Sir William Preece as chairman. The question of the unification of tests is a very important subject, for it will harmonise the standardisation of sections with the requirements of the engineers, and thus remove one of the greatest difficulties of the British steel maker, who considers that he is greatly handicapped by the unreasonableness of the different tests applied. There are 15 different committees and sub-committees, composed of 102 members, the most eminent men in the great iron and steel industries, to which the Government Departments contribute 14 representatives, and, in addition to the institutions already mentioned, representatives have been appointed by the Institution of Engineers and Shipbuilders in Scotland, Lloyd's, the Incorporated Association of Municipal Engineers, Tramways and Light Railways Association, the Railway Companies' Association, the Railway Engineers' Association, and the International Testing Association. The engineers, shipbuilders, steel merchants, and the iron and steel makers of the country are pressing the Standards Committee to publish their series of Standard Sections at the earliest possible date. The necessary authorisation has been obtained, and it is anticipated that early next month most of the conclusions of the Committees will be published.

Awards.—The Liverpool Engineering Society has awarded the Derby gold medal to Mr. John Davidson for his paper on "High-speed Steam Engines." The society's medal has been awarded to Mr. P. M. Prichard for a paper on "Fuel Economy in Factories."

Cooper-Hewitt Lamps.—The Cooper-Hewitt Electric Co., of New York, has been registered in the States with a capital of 2,000,000 dols., to manufacture electric lamps, including, of course, the mercury vapour lamp.

Imperial Telegraphic Communication.—The appendix to Mr. Charles Bright's address, which we publish to-day, embodies a great deal of information in a collected form convenient for reference, such as has not hitherto been available in this form; and as Lord Brassey said when introducing the lecturer to his audience, Mr. Bright occupies such a position that he was able to treat this important subject of Imperial Telegraphic Communication in a judicial spirit from all points of view.

The I.E.E. Dinner.—On Wednesday evening, December 17th, the fourteenth annual dinner of the Institution of Electrical Engineers was held at the Hotel Cecil, Mr. James Swinburne, the President, in the chair. After dinner there was a commendably short toast list. The popular President proposed the usual loyal toasts in his characteristic style. The "Institution of Electrical Engineers" was given by Mr. J. Balfour Browne, K.C., who made some playful references to the assistance rendered to the legal profession by electrical engineering litigants, and paid a compliment to Mr. Swinburne, who is so well known to bench and bar alike as an expert witness. The President, in his reply, turned over some very old pages in engineering history, dating somewhere about the time of the Pharaohs, and gave expression to his own original ideas regarding our present electoral system. The programme had arranged that Prof. S. P. Thompson should propose the next toast, that of "The Law," but unfortunately he was not able to be present, and his task was therefore performed by Mr. Robert Hammond, the Institution's new treasurer. Lord Justice Cozens-Hardy and Mr. J. M. Astbury, K.C., replied. "Our Guests" was then proposed by Mr. Robert K. Gray, a member of the Council, and he coupled with it the names of Mr. W. H. Maw, the President of the Institution of Mechanical Engineers, and Mr. W. R. Bousfield, K.C., M.P., both of whom responded.

It is a pity that something cannot be devised to secure better results from the musical portion of this function. The small orchestra which played during dinner was practically inaudible when once tongues began to wag, and we would wager that not 1 per cent. of those present recognised, through the hubbub of voices, Dunkler's beautiful "Au bord de la Mer," which, we may add, was not announced on the programme. Again, when the company adjourned to the Victoria Hall to listen to Mr. Ivimey's humorous sketches, only those sitting just in front of that gentleman could hear anything of what he was saying or singing. The majority, having to stand, engaged in voluble conversation, to the exclusion of all else.

THE CENTRAL STATION ENGINEER.

Mr. Edgar Hesketh, engineer to the Lymington Electric Light and Power Co., Ltd., has been appointed resident engineer under Messrs. Edmundson's Electricity Corporation, Ltd., to the electricity supply of Cromer. He takes up his duties early in February.

Mr. C. S. Walker, of Perth, has been appointed third engineer-in-charge at Bermondsey.

Hanley T.C. has appointed Mr. Edwin Seddon, of Blackpool, as junior assistant electrical engineer at the electricity works at a salary of £100 per annum.

Mr. Joseph W. Hadfield, of the Sheffield Corporation electricity works, has been appointed engineer and general manager of the Barnstaple Corporation electricity works.

The members of the staff of the Sunderland Corporation electricity works held their annual dinner on the 17th inst., on which occasion Alderman Bruce, the chairman of the Electricity Committee, in proposing the toast of the evening, said that when they got in their new three-phase plant the station in Hylton Road would be entirely filled, and owing to the rapid increase in electricity sold, in another 12 months they would have to go in for further extensions. Mr. J. F. C. Snell, borough electrical engineer, in his reply, said that for the installation of the three-phase plant he had received 37 tenders, and the two lowest of them were of foreign manufacture. He was sorry to see that foreign makers were taking the lead so much, and he thought it was time that English makers wakened up a little bit, and turned out machinery so that they could hold their own against the foreign competitor.

NEW COMPANY REGISTERED.

Severn Electric Launch Co., Ltd. (75,772).—This company was registered on December 17th, with a capital of £1,000 in £1 shares, to acquire the business of amusement and refreshment contractors, runners of electric and other cars, launches and boats, &c., carried on at Stourport as the Severn Electric Launch Co. The first subscribers (each with one share) are:—J. H. Whittaker, 23, Victoria Terrace, Dudley, electrical engineer; F. F. Doogood, Norbury Villa, Droitwich, manager; B. W. F. Whittaker, 88, Himley Road, Dudley, electrical engineer; Miss L. K. Doogood, Norbury Villa, Droitwich; Mrs. F. Whittaker, 88, Himley Road, Dudley; Miss E. Barden, Riverside Café, Stourport; and A. W. Barradale, Priory Street, Dudley, solicitor. No initial public issue. The first directors are J. H. Whittaker (chairman), F. F. Doogood, and Louisa K. Doogood; qualification £50. Registered office, Riverside Café, Stourport, Worcestershire.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Simpson Bros. (of Hapton), Ltd. (Electrical and mechanical engineers).—£1,000 debentures created November 25th, 1902, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

Sunbeam Lamp Co., Ltd.—A second debenture dated November 27th, 1902, to secure a sum not exceeding £6,000, charged on the company's undertaking and property, present and future, including uncalled capital, has been registered. Holders: C. J. Spence and J. W. B. Peace, Newcastle-on-Tyne, bankers.

Brockie-Pell Arc Lamp, Ltd. (66,602).—This company's annual return was filed on November 27th, when 79,751 shares were taken up out of a nominal capital of £80,000 in £1 shares; 2s. 6d. has been called up on each share, and 17s. 6d. per share is credited as paid on 79,744. 221 shares (on which £12 5s. 6d. has been paid) have been forfeited. No mortgages or charges.

Monte Video Telephone Co., Ltd. (27,208).—This company's annual return was filed on November 19th, when 86,492 preference and 72,680 ordinary shares had been taken up out of a nominal capital of £160,000 divided into 87,000 preference and 73,000 ordinary shares of £1 each. £159,172 is considered as paid. No mortgages or charges.

Langdon-Davies Motor Co., Ltd. (formerly Langdon-Davies Electric Motor Co., Ltd.) 55,880.—Issue on December 4th of a debenture for £100, part of a series created October 15th, 1902, to secure £6,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £3,200.

CITY NOTES.

Aron Electricity Meter, Ltd.

The directors' report reads as follows:—

The directors beg to submit the fourth annual accounts of the company, duly audited, for the term of one year ending September 30th, 1902. The audited balance-sheet, and profit and loss account are annexed; after providing for depreciation and the expenses connected with the debenture issue, the directors regret to record a loss of £6,632 16s. 7d., which, after allowing for the balance of £1,387 14s. 10d. brought forward from last year, shows a net loss on the year's trading of £4,645 1s. 9d. The directors believe the following to be the main reasons for the unfavourable result of last year's trading:—(a) The continued depression of electrical business on the Continent during the period under review. (b) The increased demand for smaller meters, caused by the change-over by central stations from low to high pressures. The company has not yet been able to profitably produce a small meter at a price which would compete with the less accurate meters in the market. (c) The absolute necessity of establishing a factory in England. The training of the labour in order to produce a meter equal to the Continental instrument, turned out to be a difficult and costly matter, and the technical staff had to be more than once reorganised. The directors have devoted much time and attention to remedying these matters. They are glad to inform the shareholders that the sale of meters on the Continent has shown some improvement since October 1st. To meet the difficulty of competition with the smaller classes of meters, Dr. Aron has already adopted a form of his meter for this special purpose. The meters turned out from the London works under the new management are giving satisfaction. All possible steps have been taken to economise the cost of manufacture of the Continental meters by concentrating the work at Schweidnitz, but this may be done gradually, so as not to interfere with the rate of production. Sir James Pender, Bart., who acted as chairman to the company from its formation, expressed a desire that one more familiar with the details of the electrical business should assume the chairmanship in order to efficiently cope with the various difficult problems which the board had to face. Sir James Pender continues to act as a director, and the board are pleased to state that Mr. Hugo Hirst, M.I.E.E., has consented to be chairman. Owing to continued ill-health, Mr. G. B. Byng found it necessary to resign his seat on the board, and Mr. S. Blumlein, a shareholder, was elected in his place. His appointment is required to be confirmed by the meeting. Two of your directors, Lt.-Col. R. E. B. Crompton, C.B., M.I.C.E., M.I.E.E., and Mr. Hugo Hirst, M.I.E.E., retire from office by rotation this year, but, being eligible, offer themselves for re-election. Messrs. Price, Waterhouse & Co. have acted hitherto as auditors, and offer themselves for re-election.

On December 18th the meeting of this company was held at Winchester House, Mr. Hugo Hirst presiding.

The Chairman, in proposing the adoption of the report, said it was to be regretted that on that the first occasion he had the privilege of addressing them he had to submit a rather unfavourable report. The difficulties which befell the company, and which were clearly and truly set forth in the report, had not reached their crisis at the end of last year, as they had hoped, but they continued throughout the year under review. Sir James Pender, Bart., who ever since the formation of the company had acted with untiring zeal and energy as their chairman, found himself confronted with problems which he thought might be better dealt with by somebody more familiar with the technicalities and intricacies of their business. Were it not that he, the chairman, had joined the board soon after its formation, and had he not, on various occasions, expressed his personal belief that they had a fair chance of success with the Aron meter, he did not think he should have liked to have undertaken that responsibility, but the assistance promised to him by the late chairman, as well as by all his colleagues on the board, including Prof. Aron and his staff, were reasons which encouraged him to try his best to get over difficulties which they had explained in their report. It was, no doubt, in their power to remedy some of them, and with others they just wanted a little luck and the indulgence of the shareholders, who, he trusted, would give the board credit for leaving nothing undone that could in any way improve their position. It should be remembered that a business such as theirs which depended on one article only, felt the influence of general prosperity or depression of individual success or mishaps much more acutely than a general business, dealing in a variety of articles. For that reason the fluctuation downward during the last two years, unpleasant as it was, left them ample hope that things would right themselves again. He would endeavour to give them, under three headings, an unvarnished view of the situation, neither optimistic nor pessimistic, but just as they honestly saw it; viz., technically, commercially and financially. First, was the meter good? Owing to their experience with the London factory, on which he would dwell afterwards, they began to be doubtful in their belief as to the high standard and quality of their meter. Their experience in London at the beginning of the year was disheartening, and knowing that they sold a great many more meters from Berlin than from London, and not being aware that similar complaints existed in such quantities over there, inquiries were made through a disinterested party of all the principal stations on the Continent who used their meter. He had a list of those before him: the Municipal Electricity Works of Charlottenberg, of Munich, of Hanover, of Konisberg, of Breslau, of Dortmund, of Blankenburg, of Bremen, the Electricity Works of Easen, of Magdeburg, of Cassel; the Municipal Water, Gas and Electricity Works of Wiesbaden; the Gas, Water and Electricity Works of Basle. These works, representing some 20,000 or 30,000 meters had, without exception, expressed themselves favourably about their instrument, and had no serious complaint. Many of them voluntarily offered an opinion that they considered it more profitable and better for the use of any central station, even though it were somewhat dearer than meters supplied by their competitors. On the strength of those reports they gained renewed confidence, and investigated the case in London, where the business up to that time had been most satisfactory, and even on the up-grade; but meters manufactured here, which apparently worked well in the works, developed certain defects after some time on the consumer's premises. In order to maintain their high reputation, they incurred the heavy expense of travelling representatives to visit the stations to put right the defects either on the spot or in their works. Those expenses formed one of the principal items of the loss incurred by the branch in London. Dr. Aron was specially called over here, and spent in the aggregate several months in England to thoroughly investigate the cause of the defects. As the result of these investigations, the directors changed the entire technical management and the methods of manufacture in London which was also a serious expense not anticipated. For some little time they would have to bear the expense of putting right former failures, as plenty of their friends, who were station engineers, had promised to order meters largely if those defects were remedied. Their building at Schweidnitz having been finished it was necessary in order to cheapen the price of the meter to confine their work in Berlin to merely assembling and testing, and accordingly they had been able to work in Schweidnitz with cheaper labour than in Berlin. The industrial aspect on the Continent had been, and continued to some extent to be, the principal cause of the reduction of the profits. They were all aware that electrical concerns on the Continent had been anything but prosperous during the past year. Their customers on the Continent consisted chiefly of private concerns. They had concessions for the lighting of various towns, those firms had been compelled to curtail their enterprise, and it was quite evident that the company had had to suffer with them. He was pleased to say that they had tangible proofs that their business was beginning to revive, and let them hope that revival would continue. The Paris branch had really done much better than in the previous year, though it did not affect the balance-sheet. To consolidate their position in France, they had to form a French company last year, in which they held all the shares, and the expenses connected therewith swallowed up what additional profits that branch had made. Vienna had done well. From America they were at the present moment without definite news, but they knew that the business was being pushed ahead there. Owing to the change-over of electrical supply stations from low to high pressure, the number of small meters required had become a very considerable proportion of the whole meter business. Last year they hoped that by turning out sufficient quantities, their present type of small meter could be made sufficiently cheap to compete with the cheapest meter in the market. Practical results had proved that not to be the case, and whilst Dr. Aron had worked hard to bring out a new type of meter which could meet with the demand, they were compelled to sell their present high quality small meters at little or no profit to keep in with the many stations that wished to deal with them. On a recent trip to Berlin, Prof. Aron had shown to him his latest "Baby" meter, and if his hopes and anticipations were realised, it would mark an epoch in the history of the company. Their financial position was at least as good as it had been at any time during their existence. They had over £28,000 in hard cash, and a stock of £45,000, which last year stood at £58,000. They had, therefore, liquidated £13,000 through the already referred to concentration and simplification of working; he was hopeful that, in the coming year, they would be able to reduce that stock by another considerable amount. He had, within the last few days, received a letter from Prof. Aron, in which he said that he was busily engaged in the new meter for small currents, and his presence at that stage of the development of the instrument was of the greatest importance. He had the strongest hopes of the result, which would, he trusted, solve satisfactorily the great difficulty to produce a reliable instrument for smaller currents, and enable the company to successfully compete in the market.

Sir James Pender seconded the motion, and the report, after some discussion, was adopted.

Metropolitan District Railway Co.

This company held a special meeting on the 18th inst. at the Westminster Palace Hotel, to consider two Bills:—(1) For empowering the company to deviate the railway authorised by their Act of 1897 and to construct other lines, to lay down electric cables, to alter fares, to acquire the Hounslow and Metropolitan Railway, &c.; and (2) for empowering the company to construct railways and works "and for other purposes." Mr. R. W. Perks explained the main objects of the Bills, which were both approved.

An extraordinary general meeting was then held to sanction the creation and issue of new share and debenture capital. In proposing resolutions with this object, the Chairman said that when they made the arrangements for the equipping of the line by electricity, they agreed to issue in part payment to the electrical company £500,000 of the new ordinary stock at 25 per cent., and the corresponding proportion of debentures—£133,000—at par. This bargain was made when the outlook of the District Co. was nothing like so bright as it was now.

Mr. E. Walford asked when it was anticipated that the line would be open for electrical working.

The Chairman said that this depended almost entirely upon when the great power house would be completed, that being the key to the whole situation. The District Co. would be ready immediately after Christmas to open from Harrow down to Mill Hill. He thought they might reasonably expect that within 12 months from next spring at the latest they would be running by electricity. The resolution was unanimously carried.

The preference shareholders also held a meeting to consider proposals recommended by the committee for giving the preference shareholders a guaranteed dividend according to the offer made by the Underground Electric Railways Co., of London, Ltd. The scheme was approved with a few dissentients.

Bastian Meter Co., Ltd.

The fifth ordinary general meeting was held on 18th inst. at the works, Kentish Town, Mr. C. Orme Bastian presiding. We are informed that the chairman said that the profit made during the last six months had been nearly 5 per cent. on the whole capital of the company, but that was really no criterion of what they would do in the future. So far they had doubled their output of meters. He held the opinion that in about five years' time the price of electricity for public lighting would be practically the same as gas was to-day, and then would commence the period when large fortunes were to be made in the electrical industry. They had been successfully developing the business in the British Colonies and on the Continent. The Spanish market had opened up so well that the directors, being of opinion that a large trade could only be safely conducted by manufacturing in the country, were in negotiation for the sale of the Spanish patents. The report was adopted.

Edison & Swan United Electric Light Co.

Mr. E. B. Ellice-Clark, M.I.C.E. (chairman), presided at Winchester House, E.C., over the 19th annual meeting of the above company, on Friday. The report submitted was as follows:—"The directors submit herewith the report and accounts for the year ending June 30th, 1902, based upon the actual working of the whole period, no part having been estimated as in previous years. After providing for all charges belonging to the year, and £1,831 13s. 8d. for items which are not strictly chargeable against it, but which the directors have deemed it desirable to include, and excluding the special charges hereinafter referred to, the profit and loss account shows that the sum of £26,311 18s. 6d. has been carried to net revenue account. Interest on debenture stocks has absorbed £18,760 18s. 4d.; £6,828 4s. 5d. has been set aside as depreciation on freehold and leasehold property, plant, machinery and tools; and the sum of £1,301 10s. 4d. has been reserved against the year's bad and doubtful debts. The directors have also instituted a reserve fund for future stock depreciation, to which they have carried, £1,488 18s. 6d., and they recommend that, in each year hereafter, a sum calculated upon the value of the stock shall be added, until a substantial reserve has been accumulated for this purpose. The result as shown in the balance-sheet is a debit against profit and loss of £2,067 13s. 1d. Special charges as detailed in the accounts, amounting, after deducting the balance brought forward from 1901, to £57,724 9s. 11d., forming no part of the working of the period under review, have been carried to a suspense account. The cost of establishing the business, goodwill, &c., £443,451 8s. 1d. has been brought forward at the figure standing in the last balance-sheet. The directors suggest that these balances be not dealt with at present. The freehold and leasehold property, plant, machinery, and tools have also been brought forward at the values stated in the last balance-sheet, with the addition of the amount expended to June 30th, 1902, less depreciation charged in the net revenue account. The shares in the Altrincham Electric Supply, Ltd., have been taken at par as in previous years. The indebtedness of this company has been increased by £5,834 18s. 3d. This matter has the careful attention of the directors, and they hope that in view of the steady progress which this business is making, no material addition to the amount will be necessary. There has been expended on capital account between May 31st, 1901, and June 30th, 1902, £15,695 1s. 3d. This was mainly authorised, and the work involved was commenced, before the beginning of the financial year dealt with in this report. The directors will exercise a strict watchfulness upon capital outlay in future. The Earl of Lichfield resigned his seat on the board immediately after the last annual meeting of shareholders thereby reducing the number of directors to three, a number less than the minimum mentioned in the articles of association. After full consideration, the directors do not advise that the board should be increased at the present juncture. Dr. J. Wilson Swan, F.R.S., retires in rotation and offers himself for re-election. Messrs. Welton, Jones & Co., the auditors, offer themselves for re-election."

The Chairman, in moving the adoption of the report, first explained the reason for the delay in holding the meeting. It was the previous custom for the accounts to be prepared by estimate to the end of the month of June, but in the circumstances which the board took office they considered that the accounts should be prepared from actual working. That necessitated enormous investigation, and with the concurrence of their auditors, Messrs. Welton, Jones & Co., they called in the assistance of another outside firm of accountants, Messrs. Harwood, Banner & Co., who were instructed to make a full and unfettered examination of the company's affairs. The result of their labours had been to confirm the figures of the board. The delay had, therefore, been unavoidable, and the board hoped it had not caused any inconvenience to the shareholders, but they could not help feeling that the time had been well spent. It had been the practice of the board to give the amount of the annual turnover, but the expediency of giving the figures of an industrial undertaking in keen competition was somewhat doubtful, and they might, with advantage, be omitted next year. For the past five years the total sales had been as follows:—1898, £226,877; 1899, £268,881; 1900, £320,444; 1901, £270,524; 1902, £246,487. It would be observed that the sales reached high-water mark in 1900; there being a decline of £50,000 in 1901, and a decline of £24,037 last year. While that further drop was to be regretted, it was proportionately much less, so it might be hoped that in spite of the greater competition, the downward progress of the sales had been arrested. The lamp sales had increased by £4,511, notwithstanding that the selling price was lowered early last autumn; but the sales in fittings continued to decrease in about the same ratio as in 1901, the figures being for 1901 21·8 per cent., and for 1902 21 per cent. Great efforts had been made at the Ponder's End works to reduce the cost of production. That branch was engaging the continuous attention of the board, for notwithstanding the great cheapening of the cost under the new order of things, prices continued to drop as rapidly as the more economical production—the greatest competition coming from the workshops of the "garrett masters" in England, and from Germany, but he was glad to say that the state of the industry in that country at the present time led one to hope that prices would not continue to fall as they had done. The cost of selling on the turnover, increased in 1901 over 1900 by 3·12 per cent; it decreased by nearly 1 per cent. in 1902, and, having regard to the increased competition in every branch of the business, it might be some consolation that, at all events, a check had been put upon the upward tendency of that important item. Turning to the other items of the profit and loss account, it would be seen that there was a slight increase in the balance of discounts, owing to the very prompt way in which the company had paid for the goods purchased during the year. The stocks had been decreased by £5,598, taking the values on the same basis as last year. That was satisfactory, showing that the company had disposed of more stock than it had made or purchased. The net value of the stock, however, had had to be considerably reduced, for, upon making a critical examination of it in detail, it had been ascertained that the book prices on which it was valued last year were considerably higher than the actual values, having regard to its physical condition and saleability. An exhaustive stock-taking had therefore been made by most experienced men, and from their examination it turned out that last year's stocks were overvalued to the extent of £40,774, so that the stock on hand on July 1st last to be carried forward into next year's accounts would be of the value of £148,892. That depreciation was a large amount, but it must be borne in mind that the fittings stock alone amounted to £76,734, and that rapidly deteriorated, not only from changes of fashion and the production of similar types which were put upon the market at prices that were constantly being reduced, but also from changes and improvements in design. On the basis of the stock valuation he had mentioned, the amount carried to the net revenue account amounted to £26,311, as against £19,514 last year, and debenture interest had absorbed £18,760. It was considered essential as a matter of principle to make some depreciation on the freehold and leasehold property of the company, and although only 1 per cent. had been set aside this year, up to the present time no depreciation had been provided under that head. In regard to plant and tools, the value at which they were carried into the balance-sheet was £81,522. Last year nothing was provided for the depreciation of those items; the account had, however, been liberally treated in years past, and the sums reserved this year appeared fair and reasonable; £15,695 had been expended on capital account at the works, almost entirely in carrying to completion the plans of their predecessors, which had proceeded too far in execution to be stopped, or even modified. Whether this money had been wisely expended was open to question The item as to provision for future depreciation might appear small after what had been said, but the £1,488 18s. 6d. was only a beginning of what should be a very considerable reserve to equalise losses. Last year £59,993 was written off for special losses and provision for bad and doubtful debts, although not placed under this head, was really such a charge. A close investigation into these accounts outstanding showed that a further sum of £2,114 had been found to be irrecoverable. By far the largest part of this sum was due from firms on the Continent in connection with the Kalk business. Formerly the company had factories at Broadheath, Walsall and Kalk, and a special provision was made last year for closing down these businesses, amounting to £9,069. The factories were not, however, closed so far as outlays were concerned. Now all the factories had been closed. In addition the lease of the depôt in Parliament Street had been disposed of, and the additional expenses of the closing were included in the item of additional losses in closing factories which amounted to £8,153, and should have been provided for previously. In addition a

further sum of £4,858 had been written off additional outlays under which term is included obsolete catalogues, outstanding low charges, depreciation in fitting up branches, and loss on the Glasgow Exhibition. These brought the total of special charges for which the year's working was not responsible to £57,907, to which might have been added £1,831 for loss on work in progress which was ordered previous to the new board's management, but which had been made a charge against the year's working. A debit balance of £57,722 9s. 11d. was carried to the balance-sheet. £5,834 had been spent on the Altrincham electric supply. For the year ending December 31st, 1901, a gross profit of £1,279 2s. 10d. was made on this as compared with £359 1s. 9d. in 1900, and in this undertaking the company had an improving property. The result was an adverse balance of £2,067 13s. 1d. on the year's working, which, added to the special charges, brought the total adverse balance to £59,792, which would have to be dealt with in future accounts. Since being in office the board had exercised such economies as had been possible to put in force without dislocating the business. Competition was, and had been, exceedingly severe, and the board recognised the serious difficulties through which the lamp trade in general and their undertaking in particular was passing. The resources of the company must be used to improve the quality of the lamp and the other articles it produced without increasing the price to the consumer. The outlook, although it forecasts a long and arduous struggle, was hopeful while the company retained its reputation for good work, and the board believed that with the economies it had already put in force extended to every branch of the company's business, it would in the end emerge successfully from its present position.

Mr. H. Wolfenden seconded the motion.

Mr. Meets said it was manifest that the past management of the company had been absolutely imbecile, but the only remark he would make was that it was absurd to put the goodwill at £443,000.

Mr. Cheetham drew attention to the enormous amount of stock.

Mr. Lake and other shareholders criticised various items, but placed no responsibility for them on the present board.

The Chairman, replying to the observations made, said that the bad debts had been accumulating for some time, but the bad debts of the company were exceedingly small. The Altrincham business they were obliged years ago to take over, but that was a property steadily progressing, and he thought it was one of the best things they had to look forward to. The cost of sales in a business of that kind was exceedingly heavy, but the percentage had been substantially reduced as compared with 1900. The present board was not responsible for the enormous accumulation of stock, and they had reduced stock to the extent of nearly £6,000. As to the policy of having depôts for the distribution of their goods, that was a matter which was carefully engaging their attention, and it was a very serious problem to tackle. They knew precisely what each depôt was doing, and they would not be slow to close any depôt which was not paying. The adverse balance would have to be dealt with in some way. As to goodwill, it was difficult to tell precisely what its value was, for obviously if they paid dividends on the ordinary shares, in a few years the goodwill would be worth what it was set out at.

The report was adopted.

Stock Exchange Notices.—Applications have been made to the Committee to appoint a special settling day in and to grant a quotation to:—Blackheath and Greenwich District Electric Light Co., Ltd.—50,000 7 per cent. cumulative preference shares of £1 each: Typewriting Telegraph Corporation, Ltd.—71,100 ordinary shares of £1 each, fully paid, Nos. 1 to 71,100.

British Electric Traction Co.—The interim dividend for the half-year ended September 30th is at the rate of 6 per cent. per annum. The directors have issued an interim report in which the affairs of the company are gone into in some detail, but any further reference to this document we are compelled to hold over until our next issue.

Johnson-Lundell Electric Traction Co.—A meeting of the shareholders of the above company was held on Monday last at the Holborn Restaurant, when our representative attended to report the proceedings, but was informed that the meeting was private. He was also refused a copy of the report.

Eastern Extension, Australasia and China Telegraph Co.—The directors have declared an interim dividend for the quarter ended September 30th of 2s. 6d. per share.

Eastern Telegraph Co.—Interim dividend of 1¼ per cent. on the ordinary stock for the quarter ended September 30th is announced.

Cape Electric Tramways, Ltd.—The directors announce an interim dividend of 6 per cent.

STOCKS AND SHARES.

Monday Evening.

Christmas week this year is a peculiarly broken period in the Stock Exchange because of the fact that the House has to assemble next Saturday. Thanks to the settlement in general stocks and shares, in which electrical descriptions are included, the carry-over arrangements have to be done at the end of the week, so that, while the greater part of the City prolongs its Christmas recess, the markets must plough a lonely furrow by themselves. The action of the Bank of England in raising its charges for loans, while keeping the bank rate at its previous level, has called forth a variety of criticism, but the directors have done all that is necessary under the circumstances, and the old year will go out with a fairly easy money market, unless there should be an unexpected crash in the United States.

The premium on new Westinghouse Preference shares is steady at ½, and there is a lot of business being done in them. An idea is abroad that the Americans desire to get all the control possible in connection with the company, and it is said that shares of the new issue not taken by proprietors will be gladly subscribed for by the people holding the bulk of the ordinary capital, who are, of course, principally Yankees. The senior Preferences have slipped back to 6.

By the way, as an example of the somewhat elastic fashion in which affairs may be conducted, we may instance a little incident that occurred the other day at the meeting of a well-known electrical company. After his first speech, the chairman said that he would address himself to the Ordinary shareholders, which he proceeded to do. A question arose, upon which a show of hands was taken, and at least one person present voted who had no Ordinary shares in his name, although at the time he was fully under the impression that he had. Yet no means were taken to find out whether this gentleman was entitled to vote.

Telegraph securities show little or no disposition to improve, despite a few dividend announcements that have been recently made. The Eastern Co. declares the usual dividend of 1¼ per cent. on the Ordinary stock, but the group fails to recover its lost ground, and Eastern Extension shares remain feebly weak. Anglo-American Deferred has given way on sales by speculative individuals professing to know that the stock will receive no dividend for the current twelvemonth, and the Preferred is inclined to fall in sympathy. Globe Telegraph and Trust Ordinary shares have eased off in consequence of the dulness in Telegraph descriptions generally.

Railway stocks, on the other hand, are fairly well maintained. For one thing, holders rarely sell on the eve of dividend declarations, and for another, there is a happier tone about the market by reason of the firmness of Consols. The Electric Railway stocks are barely altered since we last wrote, and District Ordinary at 36½ is unmoved at the addition to the board of Mr. J. Clifton Robinson, whose remarkable success with the London United Tramways Co. encourages the hope that his presence on the directorate will put a more practical heart into Metropolitan District affairs. With Mr. Robinson concerned in its direction, the promise of electrification within 12 months, assumes a much more reasonable complexion.

Electrical Supply shares are almost motionless, but a good deal of talk has been aroused by the issue of the Westminster Co.'s circular. This document gives notice that the shareholders are to be asked to confirm the action of the directors at the last meeting, when it was resolved to distribute amongst the directors, officers and staff at par (£5), the 480 new shares which had not been taken up by shareholders who had the right to claim an allotment. This was in February last, when "old Westminsters" stood about 12. The bonus was, of course, a very handsome one, and the matter having been made the subject of a kind of challenge, the resolution is to be put to the meeting of proprietors when they next assemble. There is little doubt that the board will be confirmed in their action, but at the same time the precedent sought to be set by such a high-class company as the Westminster Electric, is not a good one, and the protestants against it have much to be said for their view. Having protested, all that is necessary has been done, and they, notwithstanding their objections, should follow the excellent example set by the classical young lady who, "vowing she would ne'er consent, consented."

No change has taken place in British Electric Traction shares upon the issue of the latest report. The document is welcomed by shareholders as affording some slight reply to the numberless criticisms lately levelled at the company, and the figures which it gives are considered satisfactory. River Plate Electric Lighting and Traction Debenture stock has advanced to about 75 upon the excellent crop reports to hand from the Silver Republic, and the returning confidence in things Argentine.

Low rumbles of the aftermath of the Tunbridge Wells telephone storm continue to make themselves heard, but to all market intents the agitation is over, and National Telephone securities retain their harder feeling. The Cape Electric Tramways announces an interim dividend of 6 per cent., and the shares are quoted at 2¼. Advices from South Africa tell how Christmastide is being ushered in by great heat, which seems to be eminently inappropriate at the festive season.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotations Dec. 17th.	Closing Quotations Dec. 22nd.	Business done week ended Dec. 22nd, 1902. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	98 —102	98 —102	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2⅛ — 3⅛	2⅛ — 3⅛	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	73/6	3½%	61s.	49 — 52	49 — 52	..	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	93 — 95	92 — 94	94½	92
3,105,580	Do. do. do. Deferred	Stock	£1 7s.	5s. %	2s.	8½ — 9	8 — 8½	8½	7⅞
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	5 %	5 %	4 — 4½	4 — 4½	..	..
13,333,300$	Commercial Cable	$100	8 %	8 %	8 %	178 —188	178 —188	..	..
1,841,200	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	94 — 96	94 — 96	..	..
16,000	Cuba Telegraph	10	7 %	4½%	4 %	5 — 6	5 — 6	..	..
6,000	Do. 10 % Pref.	10	..	..	..	12½ — 13½	13 — 14	..	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	2½ — 3½	2½ — 3½	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	..	..
60,710£	Direct United States Cable	20	3½%	3½%	3½%	10½ — 10⅝	10 — 10⅛	..	..
96,300	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	100 —103	100 —103	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	122 —127	122 —127	124½	122
1,955,565	Do. 3½ % Pref. Stock	100	..	..	..	89 — 92	89 — 92	91½	..
1,534,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	105 —108	105 —108	107	106½
300,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	11⅜ — 12⅛	10⅝ — 11⅛	..	..
320,000£	Do. 4 % Deb. Stock	Stock	..	..	..	107 —110	107 —110	..	..
300,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909	100	5¼%	..	..	99 —102	99 —102	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	99 —102	99 —102 %	..	..
180,227	Globe Telegraph and Trust	10	5¼%	5¼%	5¼%	9 — 9⅛	8⅝ — 9	8⅝	8⅝
180,042	Do. do. 6 % Pref.	10	..	..	..	13 — 13½	13 — 13½	13⅛	..
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	15 %	15 %	26 — 27	26 — 27	..	..
70,000	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	100 —103	100 —103	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	39 — 43	39 — 43	..	..
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	101 —105	101 —105	..	..
72,680	Montevideo Telephone, Ltd., Ord. Nos. 1 to 72,680	1	2½%	..	..	⅛ — ¼	⅛ — ¼	..	..
86,492	Do. do. 5 % Pref., Nos. 1 to 86,492	1	5 %	..	..	¾ — 1	¾ — 1	..	..
1,983,333	National Telephone, Pref. Stock	100	5 %	5 %	5 %	92 — 94	92 — 94	96⅛	93
1,966,667	Do. do. Def. Stock	100	..	60	64 xd	63 — 65	63 — 65	64	..
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12½ — 13½	12½ — 13½	13⅛	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11½ — 12½	11½ — 12½	..	..
250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5 — 5½	5½ — 5⅝	5 5/16	..
2,000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	95 — 98	95 — 98	..	..
600,000	Do. do. 4 % Deb. Stock Red.	100	..	4 %	4 %	101 —105	101 —105	..	..
171,504	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	5 %	6 %	6 %	⅞ — 1	⅞ — 1	⅞	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	99 —102	99 —102	..	..
11,839	Reuter's	8	5 %	5 %	5 %	6½ — 7⅛	6½ — 7⅛	..	..
3,903	Submarine Cables Trust	Cert.	..	..	..	110 —120	110 —120	..	..
58,000	United River Plate Telephone	5	7 %	7 %	7 %	5 — 5½	5 — 5½	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4½ — 5	4½ — 5	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	102 —105	102 —105	..	..
15,609	West African Telegraph, Shares	10	..	..	..	3 — 4	3 — 4	..	..
30,008	West Coast of America, Nos. 1 to 30,000 and 53,001 to 53,008	2½	..	..	..	0 — ¼	0 — ¼	..	..
150,000£	Do. do. 4% Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	..	..	..	98 —101	98 —101	..	..
267,980	Western Telegraph, Ltd., Nos. 1 to 267,980	10	7 %	7 %	7 %	11¼ — 11⅜ xd.	11¼ — 11⅜ xd.	11⅜	11 7/16
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	102 —105	102 —105	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	99 —102	99 —102	..	..
88,321	West India and Panama Telegraph	10	¾%	¼%	..	5/16 — 7/16	5/16 — 7/16	..	..
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	4½ — 5¼	4½ — 5¼	..	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	3 — 4	3 — 4	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	100 — 103	100 —103	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	5½%	..	3 — 4	3 — 4	..	..
300,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	..	..	..	75 — 80	75 — 80	..	..
100,000	British Electric Traction	10	8 %	9 %	9 %	12⅞ — 13⅛	12⅞ — 13⅛	14	12⅞
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	12 — 12⅝	11⅞ — 12⅛	12⅛	11⅞
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	124 —127	124 —127	126	125
100,000	British Insulated Wire Ord.	5	20 %	15 %	10 %	7⅞ — 8	7⅞ — 8	7⅞	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5¼ — 6	5⅜ — 6	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red...	100	..	..	..	103 —106	105 —108	..	..
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	..	8 %	..	12/6 to 13/6	12/6 to 13/6	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	..	6 %	..	16/6 to 17s.	16/6 to 17s.	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	5½%	5 %	Nil	⅜ — 1½	⅜ — 1½	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	6 %	3 %	1 — 1½	1 — 1½	..	..
325,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	100 —103	100 —103	..	..
135,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	98 — 98	93 — 98	..	..
35,000	Callender's Cable Construction shares	5	15 %	15 %	20 %	14 — 15	14 — 15	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5½ — 6	5½ — 6	..	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	109 —113	109 —113	109½	109½
1,860,014	Central London Railway, Ord. Stock	Stock	..	..	4 %	106 —109	107 —110	..	..
494,093	Do. do. 4 % Pref. Stock	Stock	..	..	4 %	105 —108	105 —108	107½	..
494,993	Do. do. Def. do.	Stock	..	..	4 %	106 —109	107 —110	108½	..
1,330,000	City and South London Railway	Stock	1½%	1½%	2 %	75 — 76	74½ — 75½	75½	75⅜
85,000	Crompton & Co., Nos. 1 to 85,000	8	7½%	8 %	7½ %	2½ — 3	2½ — 3	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	101 —106 %	101 —106 %	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £8 paid, 1 to 99,261	5	6 %	2½%	..	⅛ — ¼	⅛ — ¼	..	..
17,139	Do. do. "A" shares, 01—017,139	5	6 %	2½%	..	1⅝ — 2⅛	1⅝ — 2⅛	..	..
344,028£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	74 — 78	74 — 78	..	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	77 — 82	77 — 82	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1⅜ — 1⅝	1⅜ — 1⅝	..	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	..	..	..	2⅛ — 2⅜	2⅛ — 2⅜	..	..
182,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	99 —102	99 —102	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	..	5 %	5 %	10 — 10½	10 — 10½	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	99 —102	99 —102	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	15 %	20 %	20 %	16½ — 17½	16½ — 17½	..	..
35,000	Do. do. 4½ % Pref.	5	4½%	4½%	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	109 —113	109 —113	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	10 %	20½ — 21½	20½ — 21½	20⅝	..
300,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3½%	1½%	5⅞ — 6⅛	6⅛ — 6⅜	..	..
10,000	Do. do. Pref. £10 paid	10	5 %	..	..	9⅞ — 10⅛	9⅞ — 10⅛	..	..
7,500	Parker (Thomas), Ltd., Ord., Nos. 1 to 7,500	10	..	..	..	14⅛ — 15⅛	14⅛ — 15⅛	..	..
	§Rosling & Fynn 6 % Cum. Pref.	£1	..	6 %	..	— —	19/0 to 20/0	..	..
37,350	Telegraph Construction and Maintenance	12	15 %	17½%	20 %	37 — 40	37 — 40	39½	..
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	102 —105	102 —105	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3 %	3 %	93 — 96	94 — 96	94½	..

† Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid.
§ From Bradford Share List.
¶ From Manchester Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, ⅛—⅜.
National Electric Free Wiring, ½—1.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 12—14.
Do. do. Pref. (£10 pd.), 10—11.

Bank rate of discount 4 per cent. (October 2nd, 1902).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotations Dec. 17th.	Closing Quotations Dec. 22nd.	Business done week ended Dec. 22nd, 1902. Highest.	Lowest.
		‡							
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	1	..	..	..	⅜—⅝	⅜—⅝	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs. ..	100	..	..	..	110 —113	110 —113	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	5	6 %	6 %	8 %	9¾— 10¼	9¾— 10¼	..	..
20,000	Do. do. 7 % Cum. Pref. ..	5	..	..	..	9¾— 10¼	9¾— 10¼	..	..
50,000	Charing Cross and Strand Electricity Supply	5	9 %	9 %	10 %	9¼— 9¾	9¼— 9¾	9½	..
70,000	Do. do. do. 4½% Cum. Pref. ..	5	..	..	..	5¼— 5⅝	5¼— 5⅝	..	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	5	..	..	..	4¾— 5¼	4¾— 5¼	..	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	103 —105 xd	103 —105	..	..
44,436	*Chelsea Electricity Supply, Ord.	5	6 %	5½%	4 %	5¾— 6	5¾— 6	..	..
150,000‡	Do. do. % Deb. Stock Red.	Stock	..	..	..	110 —113	110 —113	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595 ..	10	4 %	0 %	5 %	9¾— 10¼	9¾— 10¼	..	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	..	13 — 14	13 — 14	..	..
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	124 —129	124 —129	..	..
300,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	104 —107	104 —107	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000 ..	10	4 %	4 %	4 %	8¾— 9¼	8¾— 9¼	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000 ..	10	6 %	6 %	..	12 — 13	12 — 13	12⅞	..
400,000‡	Do. do. 4½% Deb. Stock, Prov. Certs. (all paid) Red ..	..	..	..	..	109 —112	109 —112	..	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	6 %	7 %	7 %	6 — 6¼	6¼— 6⅜	6⅜	6⅛
30,000	Do. do. 6 % Cum. Pref.	..	..	..	..	6 — 6¼	6 — 6¼	6	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	100	..	..	..	107 —110	107 —110	109	108½
21,000	Kensington and Knightsbridge Electric, Ord.	5	11 %	12 %	10 %	10 — 11	10 — 11	10½	..
90,000	Do. do. do. 4 % Debenture Stock ..	Stock	..	..	..	101 —104	101 —104	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	1¾— 2¼	1¾— 2¼	..	..
49,840	Do. do. do. 6 % Pref.	5	..	..	..	5 — 5⅛	5 — 5⅛	5⅛	..
250,000‡	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	95 — 98 xd	96 — 98	97	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	5 %	6 %	6½%	15½— 16½	14 — 15	15⅜	14⅝
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock ..	..	..	..	..	109 —114	109 —114	..	..
250,000‡	Do. do. 3½% Mort. Deb. Stock Red ..	Stock	..	..	..	99 —102	99 —102	..	..
10,852	Notting Hill Electric Lighting	10	7 %	7 %	6 %	14½— 15½	14½— 15½	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14½— 15½	14½— 15½	14⅝	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	7 %	8¼— 9¼	8¼— 9¼	..	..
150,000‡	Do. do. do. 3½% Deb. Stock Red ..	100	..	..	..	98 —101	98 —101	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	..	..	1¾— 2¼	1¾— 2¼	..	..
50,000‡	Do. do. 4% Deb.	100	..	..	..	80 — 90	80 — 90	..	..
65,000	South London Electricity Supply, Ord.	5	..	..	..	3 — 3¼	3 — 3¼	..	..
30,000	Urban Electric Supply, Ord., £4 pd...	5	..	..	..	3¼— 4¼	3¼— 4¼	..	..
30,000	Do. do. 5 % Cum. Pref., £4 pd.	5	..	..	..	3¼— 4¼	3¼— 4¼	4⅛	..
110,000	Westminster Electric Supply, Ord.	5	13 %	10½%	10½%	11 — 12	11 — 12	11⅛	..
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6 — 6½	6 — 6½	..	..

*Subject to Founders Shares. ‡Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Monday, December 22nd.

	CHEMICALS, &c.		Last week.	This week.	Inc. or Dec.
a	Acid, Hydrochloric	per cwt.	5/-	5/-	..
a	,, Nitric	per cwt.	22/-	22/-	..
a	,, Oxalic	per cwt.	32/-	32/-	..
a	,, Sulphuric	per cwt.	5/6	5/6	..
a	Ammoniac, Sal	per cwt.	42/-	42/-	..
a	Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a	,, ,, ...	per ton	£30	£30	..
a	Bleaching powder	per ton	£4 10	£4 10	..
a	Bisulphide of Carbon	per ton	£15	£15	..
a	Borax	per ton	£13	£13	..
a	Benzole (90 %)	per gal.	7/-	7/-	..
a	,, (50/90 %)	per gal.	5/6	5/6	..
a	Copper Sulphate	per ton	£17 10	£17 10	..
a	Lead, Nitrate	per ton	£24	£24	..
a	,, White Sugar	per ton	£31	£31	..
a	,, Peroxide	per ton	£27 10	£27 10	..
a	Methylated Spirit	per gal.	2/6	2/6	..
a	Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a	Potash, Bichromate, in casks ..	per lb.	3d.	3d.	..
a	,, Caustic (75/80%).. ..	per ton	£24	£24	..
a	,, Bisulphate	per ton	£35	£35	..
a	Shellac	per cwt.	130/-	130/-	..
a	Sulphate of Magnesia	per ton	£4 10	£4 10	..
a	Sulphur, Sublimed Flowers ..	per ton	£6 5	£6 5	..
a	,, Recovered	per ton	£5 10	£5 10	..
a	,, Lump	per ton	£5	£5	..
a	Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a	,, Crystals	per ton	£3	£3	..
a	,, Bichromate, casks.. ..	per lb.	2½d.	2½d.	..
	METALS, &c.				
b	Aluminium Ingots, in ton lots ..	per ton	£148	£148	..
b	,, Wire, in ton lots ..	per ton	£224	£224	..
b	,, Sheet, in ton lots ..	per ton	£191	£191	..
p	Babbitt's metal ingots	per ton	£40 to £130	£40 to £130	..
c	Brass (rolled metal 2" to 12") basis	per lb.	6¾d.	6¾d.	..
c	,, Tube (brazed)	per lb.	8¼d.	8¼d.	..
c	,, ,, (solid drawn).. ..	per lb.	6¾d.	6¾d.	..
c	,, Wire, basis..	per lb.	6¼d.	6¼d.	..
c	Copper Tubes (brazed)	per lb.	8¾d.	8¾d.	..
c	,, ,, (solid drawn) ..	per lb.	9d.	9d.	..
g	Copper Bars (best selected ..	per ton	£65	£65	..

	METALS, &c. (*continued*).		Last week.	This week.	Inc. or Dec.
g	Copper Sheet	per ton	£65	£65	..
g	,, Rod	per ton	£65	£65	..
e	,, (Electrolytic) Bars ..	per ton	£55	£55	..
e	,, ,, Sheets ..	per ton	£73	£73	..
e	,, ,, Rod ..	per ton	£61	£61	..
e	,, ,, H.C. Wire	per lb.	7d.	7d.	..
f	Ebonite Rod	per lb.	3/-	3/-	..
f	,, Sheet	per lb.	5/-	5/-	..
n	German Silver Wire	per lb.	1/4½	1/4½	..
h	Gutta-percha fine	per lb.	8/-	8/-	..
h	India-rubber, Para fine	per lb.	3/4½ to 3/7½	3/4½ to 3/7½	..
i	Iron, Charcoal Sheets	per ton	£18	£18	..
i	,, Pig (Cleveland warrants)	per ton	47/6	47/6	..
i	,, Forgings, according to size	per ton	From £11	From £11	..
i	,, Scrap, heavy	per ton	47/6 to 50/-	47/6 to 50/-	..
i	,, Wire, galvanised No. 8 ..	per ton	£9 15	£9 15	..
g	Lead, English Ingot	per ton	£10 15 to £10 16 3	£11 to £11 2 6	dec.
g	,, ,, Sheet	per ton	£13	£13	..
m	Manganin Wire No. 28	per lb.	8/-	8/-	..
g	Mercury	per bot.	£8 15	£8 15	..
d	Mica (in original cases) small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d	,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d	,, ,, ,, large ..	per lb.	3/3 to 7/3	3/3 to 7/3	..
p	Phosphor Bronze, plain castings	per lb.	11½d. to 1/2	11½d. to 1/2	..
p	,, rolled bars & rods	per lb.	1/- to 1/3	1/- to 1/3	..
p	,, ,, strip & sheet	per lb.	From 1/2	From 1/2	..
o	Platinum	per oz.	£4	£4	..
p	Silicium Bronze Wire	per lb.	9d. to 1/-	9d. to 1/-	..
i	Stee., Magnet, acc'd'g to desc'p'n	per ton	£58	£58	..
i	,, ,, in bars		From £15 to £119	From £40 to £119	..
g	Tin, Block	per ton			..
g	,, Foil	per lb.	1/6	1/6	..
n	,, Wire, Nos. 1 to 16	per lb.	1/6½	1/6½	..
p	White Anti-friction Metals—				..
	"White Ant" brand ..	per ton	£36 to £60	£36 to £60	..
j	Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7d.	7d.	..
j	,, 6 lea. Flax	per lb.	5½d.	5½d.	..
j	,, 3 ply 10 lbs. Russian ..	per lb.	4½d.	4½d.	..
j	,, 10 lbs. Russian, single ..	per lb.	4½d.	4½d.	..
j	,, 180 lbs. Jute rove ..	per ton	£11 11	£11 11	..
k	Zinc, Sh't (Vieille Montagne bnd.)	per ton	£23	£23	..

Quotations supplied by { a Messrs. G. Boor & Co. b The British Aluminium Co., Ltd. c Messrs. Thos. Bolton & Sons., Ltd. d Messrs. F. Wiggins & Sons. e Messrs. Frederick Smith & Co.

Quotations supplied by { f India-Rubber, G.P. and Teleg. Works g Messrs. James & Shakspeare. [Co., Ltd. h Messrs. Edward Till & Co. i Messrs. Bolling & Lowe. j Messrs. Walter H. Hindley & Co., Ltd.

Quotations supplied by { k Messrs. Morris Ashby, Limited. m Messrs. W. T. Glover & Co., Ltd. n Messrs. P. Ormiston & Sons. o Messrs. Johnson, Matthey & Co., Ltd. p The Phosphor Bronze Company Ltd.

TRAFFIC RECEIPTS.

Company.	Week ending	Receipts for the week. Am't.	Inc. or dec.*	Total to date. Am't.	Inc. or dec.*	Miles open. This year.	Last year.
		£	£	£	£		
Blackburn Corp. Trys. ..	Dec. 12	598	— 18	30,743	+ 3,920	12¼	12¼
Blackpool and Fleetwood	,, 13	142	+ 7	20,483	— 166	7½	7½
Bristol Trys. & Car. Co.	,, 19	4,843	+489	—	—	28	28
British Elec. Trac. Co.:—							
Barnsley	,, 12	146	—	801	—	—	—
Devonport	,, 12	334	— 28	21,201	+ 1,176	5	5
Dudley—Stourbridge..	,, 12	637	+ 78	37,312	+ 4,610	18½	18½
Gateshead	,, 12	794	+184	37,930	+ 7,643	10½	9½
Gravesend—Northfleet	,, 12	148	—	3,883	—	3½	—
Greenock—Pt. Glasgow	,, 12	409	+ 45	24,702	+13,291	7½	7½
Hartlepool	,, 12	196	+ 36	12,446	+ 1,247	6½	4½
Kidderminster	,, 12	87	— 5	6,083	+ 61	4½	4½
Merthyr	,, 12	147	— 30	9,787	— 1,771	3	3
Middleton	,, 12	20½	—	10,806	—	8½	—
Oldham—Ashton ..	,, 12	465	+ 19	26,366	+ 1,576	8	8
Poole	,, 12	162	+ 5	12,701	+ 11	3½	3½
Potteries	,, 12	1,480	+ 80	74,794	+ 4,910	28½	28½
Rothesay	,, 12	30	+ 7	1,917	+ 621	—	—

Company.	Week ending	Receipts for the week. Am't.	Inc. or dec.*	Total to date. Am't.	Inc. or dec.*	Miles open. This year.	Last year.
		£	£	£	£		
B.E.T. Co. (*continued*)—							
Southport	Dec. 12	186	+ 20	12,712	+ 4,662	5½	5½
South Staffordshire..	,, 12	553	—139	37,035	— 1,543	21½	22½
Swansea	,, 12	309	+ 2	23,413	+ 1,520	5½	5½
Taunton	,, 12	35	— 18	3,160	— 861	1½	—
Tynemouth	,, 12	184	+ 51	14,465	+ 2,046	3½	3½
Weston-super-Mare..	,, 10	21	—	5,588	—	2½	—
Wolverhampton Dist.	,, 12	287	+193	11,038	+ 7,191	10½	2½
Central London Railway	,, 18	7,329	+471	160,389	+12,225	6	6
City and S. London Ry.	,, 21	3,399	+157	77,854	+22,388	6½	6½
Doncaster Corp. Trys. ..	—	—	—	—	—	5½	—
Dover Corporation Trys.	,, 18	149	— 19	10,813	+ 17	3	3
Dublin United Trys. ..	,, 12	3,912	— 64	118,936	+ 2,857	46	46
East Ham Tramways ..	,, 13	411	+126	12,508	+ 2,609	5	4½
Glasgow Corp. Trys. ..	,, 13	11,516	+1,326	342,861	— 5,626	62	50½
Liverpool Overhead Ry.	,, 14	1,929	+ 33	37,157	— 582	6½	6½
Newcastle Corp. Trys. ..	,, 18	2,919	—	—	—	35	—
Sunderland Corp. Trys.	,, 14	902	— 97	—	—	17½	17½

* Compared with the corresponding period of 1901.

IMPERIAL TELEGRAPHIC COMMUNICATION.*

By CHARLES BRIGHT, F.R.S.E.

(*Concluded from page* 1049.)

APPENDIX.—STATISTICS, TECHNICAL DATA, &c.

Total Length and Capital Value of Cables so far Laid.—The total length of telegraph cable laid at the bottom of the sea down to the present time is over 200,000 nautical miles, representing about 50 millions sterling. These last figures are the actual capital originally invested in the various cable companies. The present market value of their united capital greatly exceeds that figure, the shares of the "Eastern" Co., for instance (which own by far the largest individual cable system), being worth 50 per cent. more than their original value.

Subsidies.—The following are some of the more important subsidies paid by the Governments concerned:—

In 1869 the West India and Panama Telegraph Co. had certain subsidies for interinsular cables from English and French Colonies in the West Indies for 10 or 12 years.

Some years later subsidies amounting to £32,400 per annum for 20 years were obtained from the Australian Government by the Eastern Extension Telegraph Co. for telegraphic communication with Australia.† A little later a sum of £4,000 was voted for a cable from Australia to Tasmania.

In 1879 the Eastern and South African Telegraph Co. was subsidised by Government to the extent of £55,000 per annum for 20 years for the cables on the east coast of Africa from Aden to the Cape, *i.e.*, £35,000 from Great Britain, £15,000 from Cape of Good Hope, and £5,000 from Natal—about sufficient to pay for the cable, in fact. It may be remarked that the cable was very urgently needed at that time.

In 1885, the African Direct Telegraph Co. (of the "Eastern" group) laid cables down the West Coast of Africa to the Cape, subsidised annually for 20 years by £19,000 from Great Britain and £6,000 from Germany. In the same year the West African Telegraph Co. (now absorbed with the "Eastern" group) obtained £32,000 from Portugal and £12,000 from France for cables establishing communication with these countries' colonies on the said coast. These were annual subsidies for 23 years.

A few years later (1893) the "Eastern and South African" Co. laid a cable from Zanzibar to Mauritius, *vid* Seychelles, subsidised by the Home Government to the value of £28,000 per annum for 20 years.

In 1889 it was agreed by the Home Government to pay £8 500 a year for 20 years to the Halifax—Bermuda Cable Co. for a cable between those points.

In 1896 the Direct West India Cable Co. entered into an agreement with the Home Government for £8,000 a year for 20 years in respect to a cable between Bermuda and Jamaica.

Cable Construction and Shipping Output of Great Britain.—About 100 N.M. per day.

Cost of Construction.—The cost of a submarine telegraph cable may nowadays be roughly estimated at £150 per nautical mile, but this figure varies a good deal with the working speed aimed at, as well as on the length of section and other considerations.

Speed of Cable-Laying.—About 7 knots, but up to 10 sometimes.

Slack.—5 to 15 per cent.—average, 10 per cent.

Cost of Laying.—The cost of its submersion may generally be roughly estimated at about half as much again as the cost of construction.

Life of a Cable.—This can be almost anything from 5 to, say, 25 or even 30 years, *i.e.*, before it gets into such a poor state that it becomes cheaper to lay a new line than to risk the chance of protracted, and possibly unsuccessful, attempts at repair.‡ Nowadays, when the type is carefully selected subsequent to a complete survey—assuming that the cable is of good manufacture and carefully laid—there is no reason that it should not last the longer period named, provided that the bottom be ooze, and that there is a complete absence of casual sources of detriment, such as earthquakes, ships' anchors, rocks, coral, sharks, saw and sword-fish, teredoes, vegetation, plant life, obnoxious minerals, or submarine springs—all found in shallow rather than in deep water.

Two inches of good substantial mud or ooze, which may, as a rule, be found in deep water, are the best possible preservatives for a cable; and "the deeper the water, the better the bottom, the safer the cable," may safely be taken as an axiom.

Probably the record case of freedom from repairs, is the "Brazilian Submarine"§ Co.'s St. Vincent—Pernambuco cable, which lasted nine years after being laid before any sort of fault showed itself—even in the shallow water approaches.

Cost of Maintenance; Duration and Cost of Repairs.—The maintenance of a cable is usually put down at something between £6 and £8 per N.M. per annum. There is, however, a great element of luck attached to this—to wit, the £95,000 entailed in repairing the 1874 Atlantic, occupying over a year. Luck, here, is almost entirely a question of weather and the condition of the cable near the seat of repairs. To give another example more directly dependent on the weather: the Aden-Bombay section was once broken in 1,900 fathoms for 251 days. For 148 days operations had to be entirely laid aside owing to a monsoon. Ultimately 176 miles of cable were required to effect the repair.

Value as an Investment.—Although—at first sight, at any rate—a somewhat risky property, deep-sea telegraphs have generally proved a very remunerative source of revenue. Depreciation, however, forms an important factor in the accounts of a cable-owning company. A large renewal fund is thereby rendered essential especially as the first cable laid between two given points is never regarded in these days as sufficient for its owners to rely upon solely and permanently, either in their own interests or in those of the telegraphing public.

Thus the necessary sinews of war are considerable. Nevertheless, investors in cable stock obtain a good return for their money in the long run; and examples are not wanting of very quick and profitable returns. For instance, the original Malta-Alexandria cable earned as much as £3,000 in a single week soon after it was laid, or at the rate of £117 per N.M. per annum. Again, between 1864 and 1869, the Persian Gulf Cable was earning at the rate of £100,000 per annum.

Number of Cablegrams Conveyed per Annum.—In land telegraphy, the number of messages conveyed through the British Postal Telegraphs is at the rate of 1¾ messages per head of the population per annum. Nothing like this rate can be found in the case of cablegrams. Roughly speaking, about six million messages pass over the entire network of the world's cables in the course of a year, which is equivalent to about 15,000 for each day of 24 hours. Since the first lines were laid, the number of messages have increased out of all proportion to the increased mileage of cable provided to convey them. Indeed, but for the code system, the existing cables or working staff could not possible cope with the traffic as it is at present. About 90 per cent. of the messages sent over cables are in cipher or other code language.

Rate of Cablegram Transits.—The average time occupied in the transit of cablegrams has been enormously reduced for public traffic. Where formerly it took an average of 5 or 10 hours to transmit a message between certain given points, from 30 to 60 minutes now suffice for extreme points, and between many stations the time is as low as from three to five minutes. The companies should receive all credit for these advances.

Working Speed of Cables.—Since the application of automatic (machine) transmission to submarine cables within recent years, the speed is, practically speaking, only limited by the type of conductor and insulator adopted, *i.e.*, by considerations of initial cost. The last three Atlantic cables have sufficiently large conductors and insulators to enable automatic working up to nearly 50 words a minute (simplex). The speed of cables worked manually, provided the core (conductor and insulator) is of sufficient dimensions for the length, is only limited by the speed at which the clerk can work the transmitting key, say, 25 to 30 words a minute (simplex). The working speed of any cable is dependent (inversely) on the product of the conductor resistance and the electrostatic inductive capacity of the cable and varies, inversely, with the square of the length—*i.e.*, if a cable of given type is doubled in length the working speed becomes a fourth of what it was with the original length.

Practically all cables, altogether apart from duplications, are duplexed nowadays. The result of this is to very nearly double the earning power of the cable by enabling messages to be sent in both directions at the same time without hardly reducing the effective speed in either.

India-rubber as an Insulator.—Lest the scarcity of gutta-percha should be seriously considered, attention may be called to the fact that a very considerable length—somewhere about 2,500 N.M.—of cable insulated with vulcanised india-rubber has been worked through for years, and is doing good service. India-rubber is superior to gutta-percha for tropical waters, infested with teredoes, or sword and saw fishes, such as abound in moderate depths.

Greatest known depth at the sea bottom.—4,656 fathoms (off the Kuril Isles).*

Minimum temperature at sea bottom = 34° F.

Greatest depth at which a cable has been laid = 3,200 fathoms, Pacific cable (Vancouver—Fanning section); also 3,113 fathoms Bermuda—Turk's Island cable.

Greatest depth at which a cable has been repaired = about 2,700 fathoms, between Lisbon and Madeira.

N.B.—1,000 fathoms = one nautical mile = 6,087 ft.

Longest length of any cable section laid = 3,458 N.M. Vancouver—Fanning Island (all-British Pacific line); and 3,174 N.M., Brest—Cape Cod cable.

Greatest length of any cable worked = 3,700 N.M.

In 1866 an experiment was made for working through the second and third Atlantic cables looped together. The battery consisted of a few drops of pure sulphuric acid in a silver thimble with a fragment of zinc weighing a grain and a half. The instrument used was the Thomson mirror galvanometer, the signals obtained being excellent. 4,733 N.M. of cable have, it is believed, been worked through, *for experimental purposes*, more recently.

Tariff.—A curious example of the variability of rates to spots

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* An address given before the London Chamber of Commerce on Thursday, December 4th, 1902.

† This sum was first paid in 1897 in order that the "Eastern Extension" Co. should duplicate the Penang-Australia cable, which had been frequently interrupted since it was first laid in 1870.

‡ On the other hand, by successive renewals from time to time, as necessity arises, a cable might, perhaps, in some instances, be kept going almost indefinitely, thereby saving a heavy expenditure all at once.

§ Now the Western Telegraph Co.

* Slightly greater depths have been spoken of, but in these cases the soundings have been unreliable.

about equi-distant is provided in the instance of Shanghai or Hong Kong and Vladivostock; a telegram to both the former costs 5s. 6d. a word, whereas to the latter it may be sent for 1s. 3d. a word.* Another instance, recently called attention to by Sir Edward Sassoon:—France can send a message to her West African Colony, Senegal (St. Louis), for 1s. 3d., and to Cutanu for 1s. 7½d. a word, while we have to pay 6s. 3d. a word to Accra, 7s. 1d. to Lagos, and similar tariffs to other British possessions on the Gold Coast.† Yet another case of cheap telegraphy, enjoyed by Frenchmen has sometimes been referred to: that of Tunis or Algeria at ½d., as compared with our rate to Egypt at 1s. 9d., but the cables to Algiers and Tunis are really French Government cables. We have also the Atlantic cable tariffs, which—under the existing state of affairs of 15 cables, and at any rate one company opposing a joint purse—are now fixed uniformly since 1888 at a 1s. per word, instead of a minimum £20 for 20 words as at first when a monopoly existed.‡ The Atlantic rates were lowered to 6d. for 18 months on trial; they were afterwards raised back to 1s.

Discussion.

Mr. J. Innes Rogers said there was one point in Mr. Bright's very able address which struck him very much, and that was that he dealt with cable telegraphs as if they were specially intended for purposes of war. Now he (Mr. Rogers) recollected the starting of ocean telegraphy, which was then considered to be something like the inauguration of an era of peace. That, however, had not come to pass, as they all knew, but he thought the first telegram sent by the Atlantic cable was from our late great Queen to President Buchanan, of the United States, and consisted of the words: "Peace and good-will to men." They had heard a great deal from Mr. Bright of the strategic question connected with submarine telegraphy, and it would not be doubted that it was one of the most important subjects the Government should consider, if they had, as he feared they had not, proper Intelligence officers attached to the Army and Navy. With regard to the advantages of cable telegraphy in time of peace, the enormous saving of stocks of goods which the cable enabled them to effect was very remarkable. For instance, there had been a great many complaints of late years of the want of prosperity of the docks of London. That was largely due to the existence of ocean telegraphs. The producers of goods no longer sent them on consignment to large centres like London, but kept them in the place of production until they were wanted, and then sent them to the competing country which paid the best prices for the goods. That effected an enormous saving in capital. Mr. Rogers gave other instances of the enormous advantages conferred upon commerce by ocean telegraphy, and concluded by expressing the hope that the Government would not lose sight of the important strategic aspect of the question.

Capt. Anthony S. Thomson, C.B., remarked that all would agree that the Pacific cable must, sooner or later, be duplicated by one or other of the methods suggested by the lecturer. With reference to the question as to the acquisition by the Government of this country of the control of the cables, that would only apply, he said, to those which were all-British, as it would not do for the British Government to have control or acquire cables that touched on foreign soil. He endorsed all the lecturer had said as to the admirable manner in which the Pacific cable had been laid by the contractors.

Sir H. C. Mance, C.I.E., gathered from the address that had been read that the best thing they could do was to lay as many cables as they could, so that it would be hardly worth while for a foreign power to attempt to cut them in time of war. It was not so easy as people thought to cut a cable, even when the position was exactly known, and in deep water he did not consider any foreign power would find it in time to escape some of our cruisers. As to wireless telegraphy, he was of opinion that it could never be considered as a rival to submarine cables of any length. Wireless telegraphy had come to stay, and had a very useful sphere of action in outlying places and in communication between ships, although the latter could not be relied on in time of war, owing to the ease with which it could be interrupted by another vessel.

Mr. Charles Bright, F.R.S.E., quite agreed with Mr. Rogers in his remarks regarding the peaceful effects of submarine telegraphy—indeed, he had drawn attention to that idea in his address—and there was no doubt that many a misunderstanding between Governments have been avoided which would have ended in war but for this rapid means of communication. Still, it would not do to shut our eyes to the possibilities of war at any moment, and in his (Mr. Bright's) opinion it was essential for the Admiralty to be in constant and immediate private wire communication with the Fleet of each naval station, besides the Home and Colonial Governments being in similar touch with one another. Mr. Bright wished to express agreement with Captain Thomson's remarks. In his (Mr. Bright's) opinion, however, the absorption by the State of any existing cables was open to some of the same objections as municipal trading. He was glad to find that Sir Henry Mance took the same view that he did regarding wireless telegraphy amongst other things. His (Mr. Bright's) views on this subject were fully expressed in the course of an article on "The Possibilities of Wireless Telegraphy" in the September number of the *Monthly Review*, and recent revelations in the way of "eavesdropping" from "wireless" circuits lent complete force to his statements and arguments.

* The explanation of this former tariff rests, no doubt, in the fact that the Great Northern Telegraph Co. holds a monopoly for telegraphic communication from Vladivostock to Shanghai and Hong Kong; and the explanation of the latter tariff is, no doubt, due to the Russian Government only having granted landing rights at Vladivostock on the company undertaking not to exceed that tariff for the public.

† The explanation of the former low tariff is, no doubt, partly due to the messages going overland from Senegal, besides which the line is said not to pay; and the explanation of the high tariff to Accra, Lagos, &c., is, no doubt, mainly on the basis of poor prospects of traffic. Mr. Henniker Heaton, M.P., states that he has a friend who, in order to avoid the high rates between Lagos and London, sends his cablegrams *vid* Senegal and Paris.

‡ The existing Atlantic cables represent a capital of about £20,000,000. A knowledge of the profits derived from each system is not readily to be arrived at, but from a comparison of the traffic receipts or "Money Returns" of the oldest Atlantic Co. at different periods, it may be said that the "takings" are, roughly speaking, very much the same as they were 25 years ago, *i.e.*, about £200,000 per annum. This is explainable by the fact that, although the number of messages now passing is much greater, the reduction of the rate under the influence of competition just about cancels the advantage so far as the receipts are concerned.

INSTITUTION OF ELECTRICAL ENGINEERS.

SOME LIMITS IN HEAVY ELECTRICAL ENGINEERING.

Abstract of inaugural Address by the President, James Swinburne, delivered December 4th, 1902.

(*Concluded from page* 1043.)

The Incandescent Lamp.—This simple hot carbon wire in a bulb involves the most extraordinary physical complexities. A good account of what is known—especially since he took the subject in hand—has been written by Dr. Fleming,* and the scientific manufacture of this interesting article has been fully described by Mr. Ram.† The incandescent lamp is a simple hot body radiator, and the limit of efficiency depends chiefly on the temperature of the carbon. As we are limited by the size of mains, we can only use pressures of 100 volts or 200 volts, and this limits us to carbon, or something of still higher specific resistance. The high pressure is bad for the lamp in every way. The carbon has to be longer and thinner, and therefore weaker, while the great pressure between the ends of the carbons gives rise to invisible discharges across the hot interior. The high pressure thus means that the surface of the carbon is worn away quicker, and that the carbon is thinner and less able to stand it. Inherently a high-pressure lamp is worse than a low, but the convenience as to distribution outweighs this disadvantage. The limit of efficiency of incandescent lamps is chiefly due to the variations of supply pressure. Carbon is beginning to soften at ordinary lamp temperatures, and the upper limit is soon

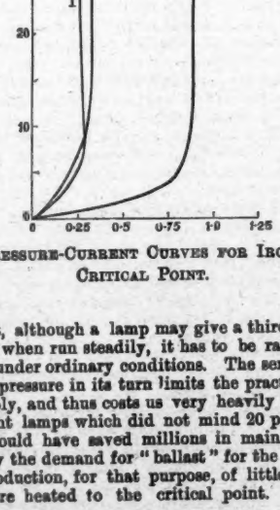

Fig. 4.—Pressure-Current Curves for Iron Wire at Critical Point.

reached, so that, although a lamp may give a third or even half a candle per watt when run steadily, it has to be rated at a quarter to make it safe under ordinary conditions. The sensitiveness of the carbon lamp to pressure in its turn limits the practical variation of pressure of supply, and thus costs us very heavily in mains. If we had incandescent lamps which did not mind 20 per cent. pressure variation, we would have saved millions in mains in this country alone. Recently the demand for "ballast" for the Nernst lamp has led to the introduction, for that purpose, of little bulbs containing fine iron wire heated to the critical point. This "ballast"

* "The Physics of the Incandescent Lamp."

† "The Incandescent Lamp."

may be used in series with the incandescent lamp. Fig. 4 gives some curves taken by Mr. M. Solomon, who has been working at this subject. It will be seen that a small resistance will allow a lamp to be run nearly at its maximum safe efficiency in spite of pressure variations, while a larger resistance will enable lamps to be run off tramway and other varying pressure circuits with good overall efficiency.

Other materials have been proposed instead of carbon. Metals have the great fault of low specific resistance. Even osmium seems unlikely for 200 volts. I have worked a good deal at this problem, but unsuccessfully so far. Most of the metals generally called infusible are not nearly refractory enough. To oust the carbon lamp a great advance in temperature is necessary. I have found a metal that seems refractory enough, but it has too low resistance, and there are very serious difficulties in making wires of it. It would seem that black oxides ought to make good filaments. Most of these substances melt easily. They conduct when first made, and go on conducting when hot. But, if then allowed to cool, it will be found that they have undergone a change and no longer conduct. The black or brown oxide of vanadium is a good example of this.

The idea of making lamps of carbides has become very fashionable lately. People have put oxides into carbon for the last 20 years. The old idea is to get hold of an oxide that radiates more light at a given temperature than it ought to, which is itself a fallacy,* while the idea of oxide in contact with carbon is chemically absurd. There is no oxide irreducible by hot carbon. There are immense difficulties in making carbide lamps. I have made low-resistance carbide lamps which stood high temperatures, but that is a very small step on the way. Mr. W. H. Story has gone on with this, beginning where I left off. After two years' solid work he has made no carbide lamps, but I believe he will eventually. To make a fine filament of an infusible material, which can be made only at electric furnace temperatures, and which is generally decomposed by moist air, is not an easy task. It is easy to think you have made a carbide lamp by incorporating an oxide in the filament material, but the resulting filament is generally mostly, if not wholly, carbon. What happens to the metal under the circumstances is rather a mystery. There is, however, a chance of enlarging our limits in incandescent lamps of the ordinary kind, but it seems strange that the melting points of all known materials should suddenly reach a higher limit. Whatever the inter-molecular forces may be that bind the particles to make solids, the vibration forces due to temperature seem to overcome the greatest at about 3,000° A.

Instead of an ordinary conductor, Nernst uses an electrolyte which stands a higher temperature. The efficiency of the Nernst lamp is about 0·6 candle per watt. It might be said that as a vacuum tube and a Nernst glower both conduct electrolytically, both being transparent, the Nernst may work by direct conversion of electrical power into radiation; but it does not work in this way, at least not mainly. The Nernst lamp, however, gets us nearer our limits both by high temperature and high pressure, so that it pushes out the limits of constant pressure distribution. One difficulty in the electrolytic lamp is to get the material to conduct at a low enough temperature, and to stand a high temperature too. The Nernst lamp is essentially zirconia, which stands a high temperature. A little basic oxide of the yttria group is added, and there is probably formed a portion of zirconate of these metals, which is fusible enough to conduct at a lower temperature. This subject needs elucidation, as the zirconates are probably like the silicates, forming a long series. Moreover, zirconia and yttria in the proportions for simple zirconate form a very infusible material. The whole subject is very obscure. We cannot say we have got anywhere near our limits of high temperature efficiency of running, low temperature in starting, or high pressure in the electrolytic lamp.

Electric Heating.—To convert heat into other energy with a very small efficiency and to send it out by expensive cables and then to degrade the energy down to heat again is obviously much dearer than burning coal or gas direct. But in many domestic cases the convenience is so great that the limit is not so low as might be thought, and electric heating for cooking and other domestic uses may develop considerably. By far the most important use of electric heating is the furnace. Here the temperature available is only limited by the volatilisation of the electrodes, and this enables us to get temperatures otherwise unavailable, so that we can get chemical actions which are impossible at lower temperatures. It is impossible to say what our limits are in the electric furnace.

Railways.—It is almost absurd to begin to consider the limits of the use of electrical transmission on railways at this date. Tubes are multiplying rapidly, and railways are putting down electric transmission on suburban lines in Europe and the States. For short lines the ordinary tramway system is used, and many schemes have been proposed. But a variable speed-gear would solve the difficulty very much better than any of these schemes. We could then have simple alternating circuits with all the consequent ease of transmission and transformation, and the trains could go at suitable speeds with high efficiencies throughout. The Leonard is an electrical variable speed-gear, but it is expensive and not very efficient. A system of oil-pumps of variable stroke is also in use to some extent for automobiles.* But machinery of that sort practically means that an electromotive must have not only a motor of, say, 1,000 KW. but what amounts to two sets of motion work. A recently developed scheme is the use of low-frequency alternating currents with laminated series-wound motors. This plan is well worth serious study.

In electric tramways there is no limit in sight. The power can be sent over any distance desired, and there seems to be no limit to the people who want to travel on electric trams. The question of electrolysis is rather that of a limit to the duration of pipe companies' property. It has recently been urged that frequent reversals of polarity of the system reduce the electrolysis very considerably.

Electrolysis.—In electrolytic copper refining, our limit is that of the copper wanted. Our electrolytic industries suffer mostly from the limits of intelligence of the investing public. It is assumed that we cannot do electrolysis in England because we have no water power. This is only an excuse for inactivity. As already explained, we can do just as well without water power. A blast furnace is much more valuable than a waterfall of similar power, because it is near coal and in an industrial district. Moreover, as already explained, the cost of electrical energy is a small portion of that of most electrolytic products. The output of electrolytic caustic is really rather limited by the demand for bleach. What is urgently wanted is some other way of storing and carrying chlorine. What are the limits in the way of electrolysing fused salt? Sodium vapour attacks all silicates. Sodium distils near the temperature of fused salt. If not volatilised it forms a conducting bridge from the cathode. It attacks iron, though slowly. Hot chlorine attacks metals, even when dry, and hot carbon cannot be exposed to the air. I could a tale unfold if I read out laboratory notes of sodium experiments on a fairly large scale. The difficulties are all incidental, though, and I have little doubt electrolytic sodium at a few pounds per ton will be in the market soon, and will affect profoundly many chemical and metallurgical industries.

In metallurgy, electrolytic solution processes are in use or on trial for the more valuable metals, such as copper and nickel. The reaction between chlorine and metallic sulphides at high temperatures brings the whole domain of sulphide ores under our sway. Thus a sulphide, say, galena, is treated with chlorine, which gives off the sulphur as sulphur, which is condensed and sold, making chloride of lead. The silver is extracted by stirring with a little lead, and the fused salt is then electrolysed, yielding pure desilverised lead and chlorine. The process is thus self-contained, yielding sulphur, lead and silver. It is specially applicable to mixed refractory ores which are now nearly valueless and very plentiful, and contain much metal content, such as the mixed lead-zinc sulphides of America or Australia. These reactions have been proved on the large or ton scale, and there is no technical difficulty. Unfortunately, mine people are somewhat ignorant of electrical matters, and it is exceedingly difficult to get them to understand or appreciate a process like this, capable though it be of paying good dividends on very large capitals indeed.

In all these metallurgical extractions we may roughly take the cost of energy as a farthing per kilowatt-hour for steam, and half that for gas. Allowing a rough average pressure per cell, we may take it that electric energy costs £100 per tonne- or ton-molecule by gas and £200 by steam. That would be £3 a ton for zinc, £1 for lead, £3 for copper and iron by steam, and half these figures by gas power. This means that the metallurgy of all the sulphides, except perhaps iron, is within our grasp. It may pay to make a pure iron, free from phosphorus, silicon, manganese, and carbon at something under £10 a ton from pyrites ores (which may also contain zinc, nickel, copper, &c.), and then add exactly the desired amount of other constituents or "physic" to produce with accuracy steels of special grades.

But our limit in electrolysis in this country is almost entirely human inertia. Commercial and financial people do not understand it, and fight shy of it. But our technical people are nearly as bad. The pure physicist, as a rule, takes no interest in electrolysis or physical chemistry, and thinks it belongs to the chemical classroom on the other side of the passage. The chemist thinks it is higher mathematics and will have none of it, the mathematician thinks it may be an exercise in differential equations; but they are all agreed that it is a sort of Continental fungus which flourishes with no roots, and that it is beneath the attention of a scientific man to know enough about it to give a reason for the broad statement that it is all nonsense.

I have now tried to bring before you the various barriers which appear to bar our progress in various directions; it is for you to get over those you can, and to get round the rest.

Variable Speed Gear.—A variable speed gear has been invented by Mr. Hall for use in automobiles; but his gear is also applicable to electromotives. It consists of two sets of oil pump engines of variable stroke mounted in a rotating frame. One set of oil pumps works on to a fixed axle, the other on to the driving axle, and the motor drives the frame round. If the frame goes at constant speed,

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* *Efficiency and Temperature.*—It is necessary to point out that the view that the efficiency of a radiating body depends on temperature only, and not on the surface, is not generally held by scientific men. Some 18 years ago I believe I was a minority of one in holding that in an incandescent body, such as a lamp filament, the efficiency depends on the temperature only, and that the colour of light depends on the temperature only. Mr Ram, in his book on the "Incandescent Lamp," holds this view, but he is an old assistant of mine in lamp making, and we are still a small minority of two or more. My reason for holding this view was that it seemed to me that if a body with a special surface gave out light of a white or bluer colour, the phenomenon would be at variance with the second law of thermo-dynamics, and the surface would be doing the work of Maxwell's demon, not by letting through only the most rapid molecules, but letting through only the vibrations corresponding with them, which is much the same thing.

* Hall's oil-pump variable speed-gear seems a good solution of the problem if it can be adapted to heavy locomotive work. It varies speed gradually and continuously, and at full speed the efficiency is 1. See note at end.

the speed of the driving axle varies according to the strokes of the pumps. If they are equal, the engine goes at half speed. If the fixed axle pumps are at no stroke, and the moving axle at full stroke, the engine goes at full speed. The speed can thus be gradually varied from nothing up to full speed, and at full speed the efficiency is 1. At half speed the pumps are doing their maximum power. If their efficiency is 0·9 the total efficiency is 0·95, and so on.

Mr. Hall purposes to use two gears and four motors. The driving axles are connected with the driving wheels by coupling rods. The electromotive is articulated in the middle to turn corners better. This system allows the train to be run by high-pressure single-phase,

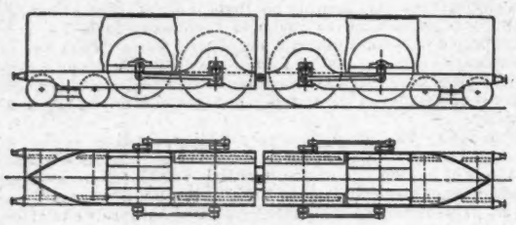

Fig. 6.

constant-speed motors. At starting, on say double torque, the current is practically zero, climbing up to full current at half-speed. The change is then made from constant torque to constant power, and the train gradually gets up to full speed with its normal current. In ordinary running the speed would be about nine-tenths of the maximum, to allow a margin, so that the oil pumps would transmit 0·1 of the actual power, or about 0·08 of the maximum power. Taking the pumps' efficiency to be 0·9 the loss is 0·008, or under 1 per cent. at ordinary speeds. This system thus allows the

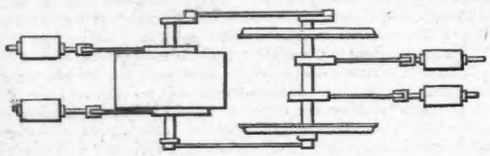

Fig. 7.

electromotive to exert any starting torque the motion work is strong enough to transmit, or the adhesion to utilise, while the motor only takes in enough power to run the mechanism round; and it allows the electromotive to run at any speed within designed limits, taking just the power needed; all this being done on a single-phase alternating-current system of convenient frequency, with every facility for transmission over great distances and distribution, and energy return on stopping. The Hall electromotive is shown diagrammatically in fig. 6.

The electric motor permits of another arrangement, however, in which the pumps do not rotate. The motor armature is on the driving axle, and the field magnets can revolve too. The field magnets work two stationary oil-pumps with variable stroke. The oil works two more oil-pumps which act on the driving axle, also with variable stroke. This mechanism has the same economical results as the Hall gear. It is shown in fig. 7.

ELECTRIC RAILWAYS AND TRAMWAYS IN EUROPE.

The Doom of Storage Batteries.—Accidents in Paris.—Progress in Berlin.

One of the sentences contained in the admirable presidential address by Mr. J. Swinburne, our abstract of which is concluded above, was rather unfortunate in the light of the experience hitherto obtained with storage battery cars for tramway working, both in this and other countries. In referring to accumulators, the President said that "the secondary battery has for a long time been on the border of success for traction work, both on tramways and on the road, and a further improvement in batteries may be expected to produce very great changes in important branches of engineering." Whatever the future may bring forth remains to be seen, but the past is a record of dismal failure for the particular purpose of tramways, and one looks in vain for any indication that the border line of success has been nearly reached in this or any other country. It is not intended on the present occasion to discuss the question of storage battery tramcars in the United Kingdom, because there do not appear to be any such vehicles still in existence, and their unhappy history is only too well known. Where then can one turn except to Germany, for facts of recent date which relate to the employment of accumulator cars on a large scale for tramways? Yet in Germany this type of car, which was generally condemned at the International Tramway Congress held in London a few months ago, is gradually being relegated to the scrap heap, and it is probable that not a single car will remain in existence by the end of next year. The last of the battery cars were removed from the streets of Berlin on the 1st inst., swept away by Government order on the ground of being dangerous and inadequate; the cars at Hagen, Westphalia, are on the point of disappearing from the tracks, if they have not already done so, by order of the representative of the Government; the 260 cars at Hanover are also to vanish by a similar command; and the battery cars at Carlsruhe are likewise to be discontinued as soon as circumstances will permit of conversion to the overhead trolley system. Let it not be imagined that the Government or its representatives have acted in an arbitrary manner towards the tramway companies concerned in the matter. Far from that being the case, the companies have actually been compelled to appeal to the Government authorities in their endeavours to disburden themselves of a system which has proved to be not only financially disastrous to themselves and to some makers of batteries on the score of maintenance charges, but has constituted a serious danger to passengers, if not to pedestrians.

It is somewhat astonishing, in view of the numerous accidents which have occurred, to find that outside of Berlin the local authorities have manifested the most determined opposition to the abandonment of accumulator cars by companies and the substitution of the overhead trolley system. One would have thought that in the public interest the municipal authorities would have approved the abolition of cars dangerous to persons, but they have opposed any change in the most decided manner. At Hagen the local tramway company, finding that all requests to the City Fathers led to no practical result, asked for the intervention of the Government "president," who eventually overruled the refusal of the local authorities, and ordered the battery cars to be discontinued within 12 months, which have now expired. A similar dispute has arisen at Hanover, where the local tramway company operates within the city and the outlying suburbs tramways having a total length of 160 miles, and has a working concession which will expire between 1937 and 1950, the longest period being for the lines outside the town. Of the total mileage 16 miles in the city itself are worked by accumulator cars, and the company has for a long time sought to introduce the overhead trolley in their place. What happened? The municipal authorities declined to give consent, but after an inquiry by the Government district committee the president decided that in view of the danger and inadequacy of the service capable of being rendered by the cars the latter should be prohibited and overhead wires substituted within a year. We now reach an extremely interesting point, which was revealed during the course of the inquiry. Prof. Kohlrausch and Herr Borries gave evidence which was very adverse to the use of accumulator cars, and it was proved by the company that during one year 253 battery explosions or fires had taken place in the cars, and that the fire insurance companies were no longer willing to accept the risk of this type of rolling stock. In view of these facts and leaving entirely on one side the financial or economic standpoint, the Government president decided on the removal of the cars on the ground of unreliability and danger. The municipal authorities then sought the assistance of the Minister of Public Works, but he rejected the appeal, and the cars will now disappear and trolley cars be introduced in their place.

The experience at Carlsruhe has been largely similar to that of Hagen and Hanover, although in this case the company is at a deadlock both with the local authorities and the Government officials. When the question of transforming the horse-car service was under consideration the company pointed out the disadvantages of storage battery traction, but it was prevailed upon to introduce this method, mainly owing to the glowing accounts received of the working of the Hanover cars at that time. The gloss has, however, worn away, and the defects which were anticipated have been realised to their fullest extent. Apart from the higher cost of fraction, the heavy cars cause so much noise in running as to arouse strong complaints on behalf of the inhabitants, whilst the health of passengers is said to be affected by the acid fumes from the cells, and travelling in the cars becomes intolerable when the windows are closed, the annoyance increasing the longer the cars are in operation. As in the case of Hanover, so at Carlsruhe have the effects of accidents been manifested. During two years there were 131 explosions, fires or other battery accidents which, as Herr von Borries pointed out at the Hanover inquiry, cannot be avoided, notwithstanding the most careful attention and supervision of the batteries. Being unable to induce the municipal authorities to consent to the abolition of the cars or to prevail upon highly placed personages to ensure this result, the company, which still holds a concession for 48 years, thought it best to dispose of its undertaking, if possible. Negotiations were therefore entered upon with the municipal authorities, but although the basis of an agreement was approved by the Mayor last February, the matter has hitherto not made any progress. The Government President has so far refused to intervene, he submitting that the company should first arrive at an agreement with the municipal authorities. Yet the company, with the lengthy concession already mentioned, has asked as the purchase price a sum which is said to be less than the present value of the quotation of its shares on the Stock Exchange. Since this was written, a Carlsruhe telegram of the 18th inst. states that the local authorities have consented to acquire the undertaking.

As stated at the commencement of this article, the accumulator cars have now been discontinued on the lines of the Grand Berlin Tramway Co. and the Berlin—Charlottenburg Tramway Co., which monopolise the tramway traffic in the German capital. The cars had for a long time been a source of public danger, and no Berliners were sorry when the Government, without consulting the municipal authorities, requested the companies to abandon the use of what

the people called "thunder cars," and to substitute the overhead trolley, or the underground conduit system in the few thoroughfares where aerial wires were, in the opinion of the State authorities, considered unsuitable. On their part, the companies welcomed the opportunity of terminating a costly experiment extending over a few years, and a few months ago the battery cars gradually began to disappear from the streets. The tramcars are now operated either on the overhead trolley or the conduit system, and a night service of cars has been introduced on certain sections down to 3 a.m. In the case of the tramway from the Stettin railway station to Charlottenburg, it has been found necessary to adopt the double trolley system in order to meet the wishes of the well-known physical-technical institute, the Reichsanstalt. The authorities of this institution were apprehensive of injury to, or the destruction of, the delicate instruments, by the use of the rails as the return, and accordingly the tramway company has been compelled to use an insulated return.

The spirit of meddlesomeness which pervades the minds of the majority of those who claim to represent the interests of London at Spring Gardens also seems to characterise the Municipal Councillors at the Hotel de Ville in Paris in regard to underground railways. There is, however, this important difference—that the London County Council seeks to interfere where it has no right to do so. Some of its members have suggested that the Council should intervene on the question of the ventilation of the Central London Railway, but although it has been found impossible to do so, the question will doubtless be pressed home in relation to new schemes when before committees of either House. On the other hand, the Paris Municipal Council, which is the lessor of the underground electric railway in the French capital, may have some right to express its opinions and enforce them, provided that the lease to the Metropolitan Railway Co. contains clauses enabling it to do so. Whether the lease embodies any such conditions we are not aware, but it is improbable, in view of the fact that the Council has asked the Prefect of the Seine and the Prefect of Police to compel the company to ventilate the tunnels, and in default to take steps to ensure the fulfilment of the object in question. This is a point which should be borne in mind by the London County Council, namely, that even shallow underground lines need ventilation—at all events, in the opinion of the Paris Municipal Councillors.

The London County Council is engaged in training motor car drivers, who are to be turned out as fully qualified men after receiving lessons extending continuously over 12 days! This fact, which deserves attention in our "Correspondence" columns on the "Tramcar Brakes" question, will, perhaps, be remembered when accidents occur on the southern lines; and it is only referred to in this place in order to emphasise the necessity for the employment of skilled men, having control of reliable brakes, as disclosed by the numerous accidents which take place on the electric tramways in Paris. M. Lepine, the Prefect of Police, in replying to questions at a recent meeting of the Municipal Council, stated that the number of such occurrences has diminished in the past two years. During the first 10 months of last year there were 548 accidents, whereas the number for the corresponding period of this year amounts to 448, although 720 additional motor cars have been placed in service. The position is therefore improving, except in the case of the East Parisian Co, and the Prefect expressed the opinion that accidents would gradually become rare, owing to the experience gained by the drivers. This optimism, to which expression was given early in November, is apparently no longer shared by the Prefect, who has just issued an order deciding that by the beginning of February next all mechanically-propelled tramcars are to be provided with wedges and lifting jacks capable of raising the axles of the cars, so as to permit of a human body being withdrawn from under the cars. This is considered to be a wise measure—for Paris—and the necessity for lifting appliances is reported to be demonstrated every day. It is said the Prefect does not intend to order ambulance attendants or apothecary assistants to accompany the tramcars—for the present, at all events.

The Italian Mediterranean Railway Co. has had in operation for some time past a main line between Milan and Varese which is worked on the third-rail system with trains consisting of a motor car and trailer. Though the length of the railway is only about 31 miles, the results obtained have encouraged the company to consider the question of increasing the rolling stock, and it has approached the General State Railway Administration for sanction to incur an expenditure of £184,000 for this purpose. It is proposed to acquire 24 motors cars with first and third-class compartments, 5 third-class coaches with mail and luggage accommodation, 20 composite trailer cars, and 8 "electromobiles" for the transport of goods. The necessity for applying for permission to spend the money is apparently explained by the relations existing between the company and the Government, and the uncertainty as to whether the State will take over the undertaking, and that of the other two principal companies at the expiration of the concession in five years from the present time. It is this indefinite position that retards the development of electric traction on the railways, and until the future outlook is assured, the companies may be pardoned if they refrain from embarking upon large schemes, except where there is a possibility of the expenditure being refunded, as it would be in the event of the before-mentioned outlay receiving the approval of the State authorities.

The municipal scheme for the construction of a shallow underground electric railway in Berlin is beginning to assume definite form, in accordance with the plans prepared by Herr Krause. At present, the project, which has been referred to a sub-committee for consideration, proposes the building of a line between the north and south of the city, of a total length of seven miles. It is to commence at Schoneburg and terminate at the junction of See Strasse and Platz H, and 5½ miles of the line will proceed in a straight direction with a heaviest gradient of 1 in 33, as against 1 in 32 in the case of the existing overhead electric railway. The tunnels are to be formed of concrete, the roof being strengthened by I girders at intervals of 5 ft.; the greatest width will be 29 ft. 6 in., and the maximum height 19 ft. 6 in. It is proposed to operate trains composed of seven carriages which will run every three minutes in either direction, and instead of using a third rail for the collection of current, the latter is to be obtained from overhead wires at a pressure of 600 volts, the return being formed by the rails. Each train will be capable of carrying 485 passengers seated and standing, and with 40 trains in the service the hourly capacity is estimated at 51,000 persons. The power station is to be built to the north of the Spree, and the construction of the railway, which would involve an expenditure of £2,800,000, would occupy four years. It is expected that considerable difficulties would be encountered in the carrying out of the scheme owing to the displacement of sewers, water pipes, gas mains and cables, and the necessity for dipping under the Landwehr Canal and the Spree and the demolition of buildings. These questions are to be investigated by the sub-committee.

The company which is investigating the question of high-speed electric traction recently concluded its trials for the present year on the military railway between Marienfelde and Zossen. When the experiments are resumed in the course of a few months, the track will have been considerably strengthened in order to allow of trials being made at higher speeds than 78 miles an hour. Herr Budde, the Minister of Railways, has decided to assist the company by providing heavy rails, sleepers, and the road bed, whilst the necessary labour will be furnished by Herr von Gossler, Minister for War. It is, therefore, only necessary for the company to supply the guide rails which are to be laid to prevent the derailment of the motor cars made by the Siemens & Halske Co. and the Allgemeine Co.

THE POPULATION OF THE UNITED STATES.

We have never felt ourselves in complete agreement with those numerous, and in other matters well-instructed and well-balanced, writers who are obsessed by the fear that this country is doomed to industrial extinction by the United States. It always seems to us that the position of labour in America is so critical, the relationship between labour and capital there so strained, the identification of interests, real or imaginary, between the most various trades unions so complete, and the amalgamation of manufacturers' combines so far-reaching, that a crisis may arrive in the States at any moment without warning; and that it is extremely likely so to do immediately the present apparent prosperity of the country receives a severe check. It must be apparent to every student of affairs that if ever industrial civil war is declared in America, the magnitude of the campaign will vastly exceed anything of the kind that has happened there or elsewhere heretofore, and that the number of commercial casualties will be incalculable. We have foes of our own household in our somnolent and self-satisfied manufacturers, our dilettante and unbusinesslike consuls abroad, our rule-of-thumb methods in commerce and industry, and in those of our trades unions which so often conduct their affairs in an ignorant, irresponsible and pernicious fashion. If we cannot abolish them or overcome their baneful influence, no number of Education Bills, no amount of free "technical" or "secondary" education, no army of free libraries presented to ungrateful ratepayers by our Carnegies and Passmore Edwardses, will enable us to derive a proper advantage from any commercial catastrophe which may overtake the States; nor in the absence of such occurrences shall we be able to hold our own against the increasing competition with which we are meeting in the markets that are open to all the industrial nations of the world.

So far as the United States are concerned, an interesting article by Mr. J. Weston in the *Nineteenth Century* for the current month draws attention to a "Weak Spot in the American Republic." In 1815 Jefferson calculated that by 1875 his country would contain 50 millions of people; before the figures of the 1900 census were published, a population of these 80,000,000 was expected—the figures themselves showed 76,000,000. But these 76,000,000 include 8,800,000 negroes, and 629,000 Chinese, Japanese, Indians, and Kanakas. We quote our Imperial population as 54,000,000, but they are all white. The United States appear to be particularly favourable to foreigners, to their children, and sometimes to their grandchildren, but eventually attenuation sets in, showing itself first in men of British descent, and therefore it is upon immigration alone that the States depends to avoid a decline in population. Even in Massachusetts, where pure Americans should be found in strength, 1,744,000 out of 2,805,000 of the population were foreign born, or of foreign parentage; and comparing these figures with those of 1890, it appears that the alien has increased four times as fast as the native.

Between 1820 and 1899 19,000,000 persons settled in the Republic 8,000,000 being natives of the United Kingdom or Canada, and the bulk coming from Western Europe. Since 1893 the majority of the immigrants have come from Eastern Europe, as the following table shows:—

	British Isles.	Germany.	Scandinavia.	Italy.	Russia.	Austria-Hungary.	Roumania.
1881 ...	153,718	210,485	73,597	15,401	10,655	27,735	—
1891 ...	122,085	92,247	41,002	51,799	43,880	56,199	517
1902 ...	45,273	28,304	48,378	178,372	107,347	171,989	7,196

It was the Saxons, Celts, and Teutons who made the United States what it is; it is they, and not the Slavs, Italians, and Austro-Hungarians on whom the duty will fall of maintaining the country's prosperity. Thus not only is the quality of the immigration to the States deteriorating to an alarming extent, but the stream of men which up to 10 years ago passed from Canada to the States has now been replaced by a larger one travelling in the opposite direction. The population question in France is serious, but in the States it is even more so, and history may be searched in vain to find a parallel for a country dependent upon foreigners for its vital strength. "Even were all her 76,000,000 white, which they are very far from being, she could no more play the world part that the United Kingdom has played for a century than France could. She has not the staying power," says Mr. Weston.

METROPOLITAN ELECTRIC SUPPLY CO.'S ARBITRATION.

(*Continued from page* 1023.)

Resuming his address on 13th inst., Mr. Moulton said that the position of the company at the moment when the negotiations for purchase commenced was a most serious one. In their desire to get the important practical advantages of a Willesden supply, the company had accepted powers which left them under all their old obligations. The whole plans of the company were for expending their future capital in the development of their huge concentrated generating station at Willesden, and when they came to realise what an enormous factor in electric supply capital outlay was, they would realise that that which would have required them almost to duplicate their capital outlay, would have been practically ruin to them. It might be said that if the company were unreasonably compelled to double their capital outlay, they would take it out in price, but that was not possible, because they were to have the same price as the mid-London Order. In the mid-London area they had active competition at the hands of a most effective rival. No one could say that the Charing Cross Co. had not shown great enterprise, and that it was not a company that supplied the public—should he say in a very pushing manner. If they were going to raise their price in Marylebone, they must raise their price in the Strand, and if they raised their price in the Strand, practically it was the abandonment of the district altogether. They could only keep that by keeping their price down to the price on a truly competitive area. It was no use saying—but Marylebone was largely private lighting; the other was more largely trade lighting. If they were going to drop their trade lighting down to competitive prices, the whole of their lighting in the Oxford Street district must be lowered. If they were going to raise their price to a disproportionate one for private lighting, they would lose the whole of the private lighting in the Strand district. The consequence was that they were in hopeless difficulties if that was insisted upon—they must either adhere to their Willesden plan at the cost of double capital expenditure, or they must abandon their Willesden plan and make Marylebone a self-contained system leaving their capital at Willesden to be a mere stand-by. They could not doubt, looking at the whole of the evidence, that at whatever cost it might be, the company had determined to adhere to Willesden. That would have meant that they would have had to provide that large expenditure in Marylebone; that duplicate instalment which they would scarcely use at all, and when it came to purchase they could not have put Willesden upon the Borough Council. When he came to consider the question, not only of the magnitude of capital charges, but the question of security for capital charges, he thought those would be considerations of great importance. In valuing the undertaking, he should say it was just like an undertaking depending on locality with no lease; practically holding on sufferance. The future of the company depended upon chances, on diplomacy, on arrangements, and on giving advantages for the purpose of purchasing the non-enforcement of rights on behalf of the Borough Council. They had committed themselves to a system which *de facto* was inconsistent with their contractual obligations with the Borough Council, but which they had before Parliament and to the Borough Council undertaken should not interfere with those rights. They paid the price and got it, and no doubt they thought that when they got it they would somehow or other manage. But "somehow or other manage" was not the sort of security on which they lent at a low price, and therefore he should ask the tribunal to bear those considerations in mind, as influencing them as to the real commercial value of the undertaking, and the price that ought to be paid for it. Turning to the question of capital outlay, the learned counsel said that an electric lighting company had to have effective plant for maximum demand—the maximum demand at any moment. It had to have effective plant for that, which meant plant protected by adequate spares. But although they had got to deal with maximum, they were bound to transform it in some form into average, in order to enable them to scheme the supplying machinery, and to do that they created what was known as a load factor. In the present case the load factor was taken at 12 per cent; 8,760 were the number of hours in the year, 12 per cent. of 8,760 hours came to 1,051, therefore a 12 per cent. load factor, a kilowatt which turned out 1,000 watts would turn out 1,000 units in the year. The plant was working at its full amount for only 12 hours out of 100, and that enabled them to say that for every 1,000 units turned out they must instal 1 kw. One hundred pounds might safely be taken as the cost of installing an effective kilowatt. It was not to be wondered at that the company had a high capital charge in their system by working Willesden. They generated at a distance, and they had considerable transmission loss in going from Willesden to the various stations. They transmitted in the shape of alternating current, he believed it was two-phase. They had to transform that down to a moderate pressure for the purpose of driving their motor-generators, with which they were going, in future, to supply their continuous current in that district, which was substantially to them, Marylebone. There was a very heavy loss of something like 15 per cent. there, and there was very expensive machinery in motor-generators. So, if they contrasted that with systems which generated immediately at the pressure at which they distributed, it was clear that there must be a good deal more plant. Therefore he thought that the tribunal would agree that the moderate figure of £100 which he had taken had never been contradicted. That figure was one of great importance, for it bore not only directly upon the profits of the company, but directly on the economic and commercial value of the undertaking by reason of the responsibility it put upon it to find throughout its life fresh capital, and it also had the gravest effect on whether or not the company could afford to go to low prices for supply of electricity for special purposes. With regard to that he specially referred to the question of whether the company could count on a considerable source of profit from power. When he came to power, he at once admitted that he must not rely upon the £100—the £100 he only applied to lighting—the capital expenditure per 1,000 units sold for power he would take at £60. But when they came to consider what the corresponding revenue deduction for that capital outlay was, they would find that it put the most formidable obstacle in the way of the company ever making any profit from the supply of power. As to the actual cost at which power could be turned out, the evidence given had placed it beyond contradiction that it must be supplied at 2d. per unit and under, while it would cost them more than that to produce it. With regard to the probable demand for power purposes, Mr. Moulton said the only business in Marylebone was power in small quantities at practically lighting prices, or slightly lower than lighting prices. They were told by the company that there would be a demand for power for the purposes of lifts. In his view, any person who introduced a lift customer to an electric lighting company ought to be considered a deadly enemy. The best lift customer they could imagine in London would be the Central London Railway, where the whole of the traffic was done through lifts in every single station, and yet they were told by Mr. Parshall that although they had 50 lifts working for 18 hours a day, and working them, of course, continuously, they only got a load factor of 10 per cent. In other words, they were bad lighting customers. As to heating, heating would certainly never be used, or very rarely used, and he should think it would always be a poor load factor unless it were cheap, but the expense must be very large. He was not going to deal with the question of power for factories—there would be a certain number of sewing machines driven, but there was no question of a substantial demand for them. The whole of the case turned on the question of automobiles, and at this present moment there was no demand for that, and Mr. Crompton said that this demand would not be very profitable unless people charged their automobiles during the night in their own stables, and they had called evidence to prove that that was absolutely impossible. First of all, these secondary batteries, although they had had them for 20 years, were very liable to get out of order; and it was impossible to allow them to go on all through the night when the charging might go wrong. The only way in which automobiles would be used, driven by electricity, was in the hands of people who had large yards and changes of batteries—who could put in a battery as soon as the vehicle came in, and send it out again with a new battery. Under those circumstances they would probably have their own installation, but if they did not, they would go to some place where they would get it very cheap, and he could see no reason to think that they would get it very cheap in Marylebone, for the capital charges alone, plus the coal, and leaving out all wages and everything of that kind, would come to practically 2d., and nobody dreamed of automobile proprietors working all their establishments with electricity at 2d. They would very much sooner generate themselves. If they generated it themselves, they would have no transmission losses; they would generate just as they wanted it; they would have such a very large demand for it, if it were on the scale suggested, that it would be worth their while to do it in that way.—Adjourned.

Resuming his address on Tuesday, December 16th, Mr. Fletcher Moulton said he now intended to consider what allowance out of revenue they must make in respect of capital charges, and he intended to take those capital charges throughout as £100 for lighting and £60 for power. For every 1,000 units sold they had a capital charge of £6 per year for light and £3 6s. if it were power. Supposing they said that the undertaking had a capital of £200,000, which was the value of the plant in Marylebone which they employed. He was only taking £200,000 as an illustrative figure—call it a quarter of a million, or whatever they liked—it had a capital that had to be estimated by valuation. When they considered what a capital of a business was at any moment they must value the business. He remembered that a learned Judge once decided against him, and said that the capital of a business was that which

was put in—it was a matter of complete indifference whether it was there or was not there. He in vain suggested that Sir W. Siemens put into his business half-a-crown when he came into it, and they would see that the value of the business was more than half-a-crown. When the question came to the Court of Appeal, Lord Justice Fry remarked—a firm has two ships, each worth £30,000, capital £60,000. One goes to the bottom—its capital is still £60,000 I understand the Judge to say. The company wished it was . . . . . they must estimate the capital from the direct valuation at the moment they were considering it. Of course that was the universal method adopted by all accountants, so that in regard to the value of the capital in Marylebone, he should take a valuation which was entirely a matter of evidence. A much more difficult question was the valuation of the plant outside Marylebone, which was at this present moment supplying plant for Marylebone. How were they to consider that—it did not represent articles that were to be taken at all—it represented outside assistance to the undertaking—the undertaking for which the West London Provisional Order was granted, for the purpose of performing its duties. It appeared to him that in dealing with that, the task of the tribunal was much the same as in dealing with the extremely difficult question of future capital which could not be borrowed. They had got to get in some way or other the money equivalent for that assistance. They had got to get a revenue charge which might in fairness be considered to pay the price for it. If they could not get it into a revenue equivalent, their task was hopeless. They had got to value an undertaking which depended upon outside assistance, not only now, but on the scheme of adding capital. That outside assistance was in the shape of what he would call manufactured electricity—the manufactured article. He was going to allow for the cost of manufacture, so far as it depended upon working cost, but they could not produce it without plant, and he was going to consider what allowance he ought to make in respect of the charge for plant which was necessary for that outside assistance. Take it as a fact that £200,000 of plant at Willesden at this present moment was required in order to give them that outside assistance, and the question to be considered was, What was a fair price for him to pay for that outside assistance?

The Umpire: Your valuers said, We give them now £180,000, the value of the capital as it exists; we shall take 4½ per cent, upon that, and deduct it from the profits, because, with that £180,000 handed from them, they could, apart from using it in trade, make 4½ per cent. upon it.

Mr. Fletcher Moulton: Yes; they there meet with the question, If you had to use it. The tables I have put in have not treated it in that way. Continuing, the learned counsel said that if they paid them the £200,000 now, it appeared to him they were entitled to charge them with interest on it, because they used it all the time. If, on the other hand, he took it that they paid the £200,000 *then*, then they must take the discounted value now.

Mr. Ryde: Are there not two things to be considered—first, whether a particular piece of plant has depreciated by age, and then the allowance for present value, as against deferred value, which is a different thing. We must not confuse those two things.

Mr. Fletcher Moulton: No, and I have only been upon the question of the effect of age, because I have only been considering the cost of hired capital. I have not been considering the question of valuation yet. I have only been considering the debt that you must make against profits by reason of hiring your capital. The second question, which you say must be kept distinct, is the question of valuation, and that I will come to as quite a distinct question.

The Umpire: If, in order to meet the objection which is raised by Marylebone not having the area handed over to them with a self-contained supply, the company were prepared to hand over to Marylebone in meal or in malt what it would cost Marylebone to give itself a self-contained supply, that would be treating you quite properly, would it not?

Mr. Fletcher Moulton: I feel very much inclined to adopt Sir Frederick Bramwell's celebrated answer—yes and no.

Mr. Ryde: Is this the way you put the argument? You say Marylebone was not self-contained but should have been. Mr. Cripps says—be it so, and to make it self-contained is £100,000 or whatever the figure is. Then you say that that is not enough, because if you put that £100,000 worth of plant, or whatever the figure is, in Marylebone, and work it as you were bound to do, still you would not have got down the working cost at so low a figure as the actual working cost.

Mr. Fletcher Moulton: Yes.

Mr. Cripps remarked that the words "self-contained" might not have the same meaning. When it was a question of profit they stood in the position of being entitled to work economically—they had the advantage of it, and when it was a question of working in Marylebone in future, they had to take the capacity of the plant.

Mr. Ryde: I was not deciding against you, of course.

Mr. Cripps: Quite so, only I did not want a misunderstanding.

Mr. Fletcher Moulton said Mr. Cripps must remember that he had based on that his estimate of future profits—in other words, he had based on user his estimate of future profit. The learned counsel then went into details as to the internal capital of the company as represented by its buildings, plant, machinery, &c., and had not finished his speech when the tribunal adjourned until Thursday, December 18th.

G.N. Railway Stores.—The contract for the supply of telegraph material to the Great Northern Railway during 1903 has been placed with the St. Helens Cable Co.

ELECTRICITY AS A COMPETITOR OF GAS.*

By W. R. RAWLINGS, A.M.I.E.E.

(*Concluded from page* 1050.)

I mentioned that the same gas company (the Wandsworth) also issued a booklet by Mr. Ebenezer T. Pye, and on turning to this, we find on the second page this startling announcement:—

"Coal gas recommended in preference to electric lighting for the better preservation of art treasures in the Birmingham Art Gallery."

This startler is given on the authority of Mr. P. F. Frankland, F.R.S., but on reading his report I find that the question was that of ventilated gas lighting *versus* unventilated arc lighting. Everyone must admit that this extract, placed as it is, is most unfair, and the same ruling applies to almost all the quotations given.

Another sample of this literature comes from the Lea Bridge Gas Co., who issue a couple of leaflets quoting Sir W. H. Preece as reporting to the Maidstone Corporation and advising them not to adopt electric incandescent lamps in place of the gas incandescent burners for street lighting, and placing the cost at £6 per annum for electric, and £2 18s. 3d. for gas. This gas company sums up by asserting that what applies to street lighting will apply to all other positions. We all understand the absurdity of such an assertion, so there is no need for me to comment further upon it, and in any case this last example is only a little over 2 to 1, not 13 to 1.

I think the foregoing examples of the class of literature sent out by the gas company are sufficient to show the need of our attention to that department.

Referring to the mains department, the supply company's engineer appears to be surrounded with many difficulties, which bring about delay and consequent loss of orders. To lay in a new service, they have the local authorities to contend with who require a month's notice; then their orders are fluctuating, necessitating oftimes the holding over of connections for many days. How different this is from the action of the gas companies, whose position is far more fortunate! I have known cases where the service has been made and the light used on the same day as the contract was signed, and there is no doubt that the business-like control which the gas companies have over their mains, places the electrical industry at a disadvantage, and everything possible that could be done to expedite the time it now takes to make an electric light connection would, without doubt, improve business generally.

Further, I think it is a duty of every supply company to attend more promptly than at present to urgent orders for repairs to their own main fuses, for it is generally complained that should such an accident happen, there is very little chance of having the same put in order until the following day, and this is a point which, my hearers know only too well, is brought up as an objection against installing the electric light.

In complying with the rules drawn up by the supply company and the fire offices, and it may be consulting engineers also, it is impossible to interpret the three combined, and I venture to suggest that such a state of affairs is one, if not the worst, obstacle in the way of electrical contractors; it is to be hoped that the past efforts of the Institution of Electrical Engineers and their new rules will do much to remedy this evil.

In the Metropolitan Boroughs alone, there are no less than 11 different voltages at which supply is given, and as some of these are with alternating current at several different frequencies, the difficulties in the way are many. When we add to these objectionable features in electric light supply, the various prices and systems for charging for current, the 48 hours' notice to connect, a month to get an extension of mains, (not the fault of the company), and the differences in the wiring rules and requirements of the respective supply companies, &c., we find that we are surrounded by confusion, and compelled to put a deal more money and energy into our businesses than is required by gasfitters.

All these things tend to retard business in our direction, and it behoves us to protest against it.

How different from the example I gave of obtaining a supply of gas is the usual procedure in electric lighting.

The companies do not, as a rule, inspect the work during progress and advise as to their requirements, but leave it to the testing engineer to examine, and then often refuse to test or connect until some alterations in a few details are made; he will add to the feelings of the contractor by politely informing him on leaving that the fee for testing will be 10s. 6d., as his first appointment was useless, and that a copy of the rules may be seen at the company's office.

It is just possible that, after these alterations have been made and supply given, the fire office inspector drops in and insists upon some further changes. I do not wish to imply that the rules of the companies and fire offices are at fault, but that as the rules stand the contractors cannot possibly satisfy all concerned, the consumer often comes to the conclusion that the work is faulty, and the contractor in the end suffers for a state of things over which he has no control.

The various voltages to which I have referred compel all contractors to hold a stock far in excess of the amount required for the business done; as an instance, if you keep, say, only three sizes of lamps in clear and obscured glass, you will require no less than 66 different varieties to meet your customers' demands, and if you include fancy and special lamps, the quantity becomes enormous. The accessories are nearly as bad, as each company has its own

* Abstract of paper read before the London Electrical Contractors' Association, December 2nd, 1902.

ideas of its requirements. The question of voltage also causes great delay in delivery, and increased cost of motors and similar apparatus; in fact, it is one of the principal problems to be faced, and I would suggest that its importance requires the attention of the Board of Trade, with a view to standardising the E.M.F., for the metropolitan boroughs at least. The importance of this point applies equally to the frequency, and it is clear to everyone that the proper control of these important features would tend to the standardisation of all lamps and apparatus.

The facilities offered by the gas companies to gas light contractors and their customers are altogether different from the conditions under which electric light contractors have to work; they lay in their services at comparatively very short notice, and then provide, and sometimes connect, the meter to their main, and leave the gas light contractor to test and connect.

That rules are necessary we all know well enough, but I maintain that they should not tie our hands and our intellects so tightly as they do. They ought to be arranged in a more "negative" manner, and not tell us what we *may* or *must* use, but just say what we may not use.

The rules of the supply companies and the fire offices vary to such an extent that, in nine cases out of ten, they disagree in what to us contractors are vital points.

One of the worst rules in this respect is that relating to *testing*. Leaving out the fact that the supply companies' requirements in this respect vary to a great extent, they all, nevertheless, insist upon some certain standard.

I have known over 12 fire offices to be interested in one installation, and as each one had its separate rules, and the supply company also had its own set, it would have been absolutely impossible to conform to all their requirements.

A further cause of complaint, and one which acts as a great hindrance to new business, is the charge that supply companies make the consumer pay for such items as "connection," "extra long service," "meter rent," &c.

A friend of mine living at Ealing is a customer for electricity to the value of about £20 per annum. He also has to pay £5 per annum for the street main, which the Ealing Council refused to lay under any other conditions. His house is one of many in the same road, and not in the middle of a field, as one would at first suppose.

My firm a short time since guaranteed a three years' minimum supply to a supply company for a service to a building because the consumer refused such conditions and the supplier insisted on the terms. I mention this as evidence that contractors do more to encourage the business than the supply companies.

Yesterday I received a letter from a large college where electricity has been recently installed in a portion of the building, and the results are as follows:—

Oct. and Nov., 1901.				Oct. and Nov., 1902.			
Gas	£63	9	0	Gas	£34	13	3
				Electricity	20	12	0
					£55	5	3

showing a saving of £8 3s. 9d. in the two months over the corresponding period of last year. The report which follows is even more interesting, since they state that the lighting is superior and the air of the rooms purer, with the result that many more students can work in the same space; upon this report follows an order for further extensions. I could give many such illustrations, but with the ever-increasing demand for electricity its own tale is told.

Referring to the figures given by the gas company wherein they say that for gas costing £1, electricity will cost £13 (but to be moderate I am willing to take it at 10 to 1 for the purpose of illustrating the absurdity of their calculations). Take, for example, a small 12-roomed house; one would require at least 20 points whether it be illuminated with gas or electricity. Now, the renewal of 20 mantles would cost (as per the Gas Co.'s quotation) 3s. to 5s. per annum—say 4s.; we thus have a total bill for mantles alone of £4.

From figures which I obtained from two supply companies, and from my own experience, a 12-roomed house would require about 30 electric lamps installed to properly illuminate the same, and, as you all know, such a number would give a far superior distribution of light than 20 incandescent gas burners.

The cost for lighting 30 lamps would amount to about £12 per annum as per the returns of the supply company (I have many illustrations where 100 lamps are installed where the cost works out about £20 per annum, but I desire to fully cover the illustration). Now add to the electricity bill of £12 say 30s. for renewal of lamps, we have a total cost of £13 10s.

Our gas friends state that electricity costs 10 times more than gas; if that were true the total cost of lighting the 12-roomed house would be £1 7s. by gas, or one-third the cost of the mantles alone.

If we take the foregoing illustration on the liberal lines set out by the gas writers of six to one, the cost should be £2 5s., or a little over half the cost of the mantles.

I will leave my hearers to draw their own conclusions.

Cleaton Moor.—The U.D.C. has decided to take no action in respect to the application of the West Cumberland Electric Tramway Co. for an extension of time for the completion of the work.

NEW PATENTS, 1902.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

26,999. "Improvements in and connected with electro-motors and similar electrical apparatus." J. W. MACFARLANE, of the firm of Watson, Laidlaw and Co. December 8th.

27,001. "Improvements in and relating to electric bells and telephones." O. NOLTE and C. HAGER. December 8th.

27,072. "An improved form of current carrying wire for use in overhead electric traction; also applicable for haulage purposes." J. WHITEHEAD. December 8th.

27,073. "Improvements in electrical conductors." J. B. SCAMMELL. December 8th.

27,074. "Improved electrical cut-out or fuse holder." F. H. HEADLEY. December 8th.

27,088. "Improvements in electric signalling in connection with tramways." H. HIRST and W. WOOD. December 9th.

27,089. "Improvements in electric power transmitters for sewing machines and the like." J. ROSENBERGER. December 9th.

27,090. "Improvements in apparatus for working railway points and signals by electric power." F. W. WEBB and A. M. THOMPSON. December 9th.

27,096. "Improvements in combined switch and fuse." H. H. HORNBY, C. N. VAN CLEEF, E. W. ANGER, JUN., and M. NEWGARD. December 9th. (Complete.)

27,132. "Means for applying electricity to the body superficially." A. R. MOSLER. December 9th. (Complete.)

27,133. "Improvements in enclosed arc lamps." V. RECLUS, H. C. F. M. PETITDIDIER and T. M. SCHMITT. December 9th.

27,161. "Improvements relating to electricity meters." W. E. EVANS. (Allgemeine Electricitäts-Gesellschaft, Germany.) December 9th. (Complete.)

27,168. "Process for manufacturing the current-conducting connection between the filaments and the conducting wires in electric incandescent lamps." J. PLECHATI. December 9th.

27,179. "Improvements in the reduction of compounds by electrical heating and in apparatus therefor." E. G. ACHESON. December 9th. (Complete.)

27,180. "Improvements in accumulators or secondary batteries and the preparation of electrodes therefor." C. F. A. VON WELSBACH. December 9th.

27,184. "Improvements in devices for operating electrically the points on electric tramways and railways." J. P. TIERNEY and J. MALONE. December 9th.

27,232. "Improvements in and relating to rotary electric contacts for high tension circuits." F. C. BLAKE. December 10th.

27,237. "An improved electrical connection fitting for use in conduit boxes and the like." G. BYNG and H. A. GASPERD. December 10th.

27,239. "A new or improved combined electric incandescent lamp and switch." F. J. BIDDALL. December 10th.

27,247. "Improvements in or relating to deck standards used in electric traction." E. J. SMALLCOMBE. December 10th.

27,265. "Improvements in or relating to electric storage batteries." W. C. HEAD. December 10th.

27,272. "Improvments in the method of selective electric signalling." H. H. LAKE. (J. S. Stone, United States.) December 10th.

27,284. "A new method of retarding the back running of electric tram cars." C. H. SPENCER. December 11th.

27,295. "Improvements in apparatus for amplifying electro-magnetic signa waves." H. H. LAKE. (J. S. Stone, United States.) December 11th.

27,301. "Improvements in the method of amplifying electro-magnetic signal waves." H. H. LAKE. (J. S. Stone, United States.) December 11th.

27,308. "Improvements in apparatus for cleaning the grooves of electrical tramway rails and for facilitating the passage of the electric current." A. T. M. MATHER. December 11th.

27,322. "Improvements in electric switches." H. PIEPER. December 11th.

27,369. "An improvement in synchronism indicators for use in connecting alternate current or polyphase dynamo-electric machines in parallel." SIEMENS BROS. & Co., LTD. (Siemens & Halske Aktien-Gesellschaft, Germany.) December 11th. (Complete.)

27,373. "A new or improved galvanic cell." G. PEARSON and L. FIELDER. December 11th.

27,374. "A new or improved electrode for galvanic cells and a method or process for producing same." G. PEARSON and L. FIELDER. December 11th.

27,397. "Improvements connected with trolley poles of electric cars or locomotives." J. S. RIGBY and E. GORMLY. December 12th.

27,443. "Improved switchboard for effecting telephonic intercommunication." J. YOUNG. December 12th.

27,472. "An improvement in cooling devices for continuous current dynamo-electric machines." SIEMENS BROS. & Co., LTD. (Siemens & Halske Aktien-Gesellschaft, Germany.) December 12th. (Complete.)

27,475. "Improvements in coin-operated apparatus for administering electric shocks." W. C. HAWKES, F. MOUFLET and T. E. TAYLOR. December 12th.

27,476. "Improvements in or relating to electric railway or tramway traction." W. S. BOULT and C. R. BOULT. December 12th.

27,497. "Improvements in water pipe cases for electric bells and telephones." L. W. DE GRAVE. December 13th.

27,509. "Penny-in-the-slot telephone call box." T. HOLME. December 13th.

27,540. "Improvements in or relating to arc lamps." T. L. CARBONE. December 13th.

27,557. "Improvements in and relating to electrical resistances." R. MARTAIN AND PORZELLANFABRIK KAHLA, FILIALE HERMSDORF-KLOSTERLAUSNITZ. December 13th. (Complete.)

PUBLISHED SPECIFICATIONS, 1901.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

4,509. "Improved composition of paste for filling the cells of reticulated accumulator plates." H. J. H. Pickard and J. S. Evans. Dated March 2nd, 1901.

4,575. "Improvements relating to electric power distribution." H. H. Lake. Dated March 4th, 1901.

4,576. "Improvements in electric furnaces." R. C. Contardo. Dated March 4th, 1901.

4,586. "Improvements in primary batteries." C. N. Gaurentes. Dated March 4th, 1901.

4,597. "Improvements in electric demand indicators." A. Wright and Reason Manufacturing Co. Dated March 4th, 1901.

4,695. "Improvements relating to the regulation of dynamos." F. Strickland. Dated March 5th, 1901.

4,709. "Sound and fireproof walls for use in connection with telephone apparatus." H. Schäffer. Dated March 5th, 1901.

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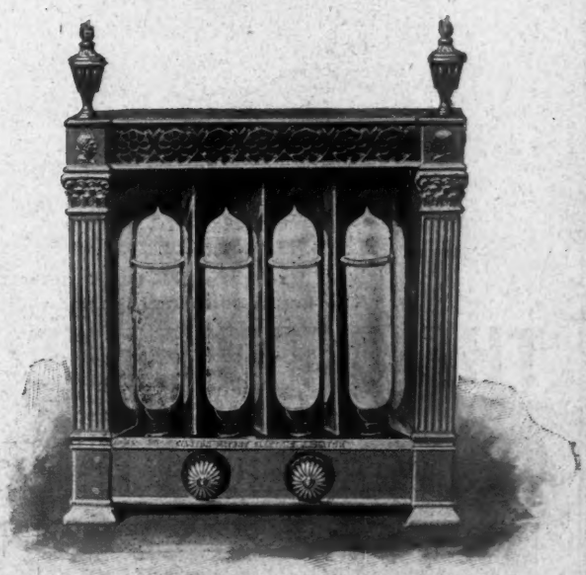

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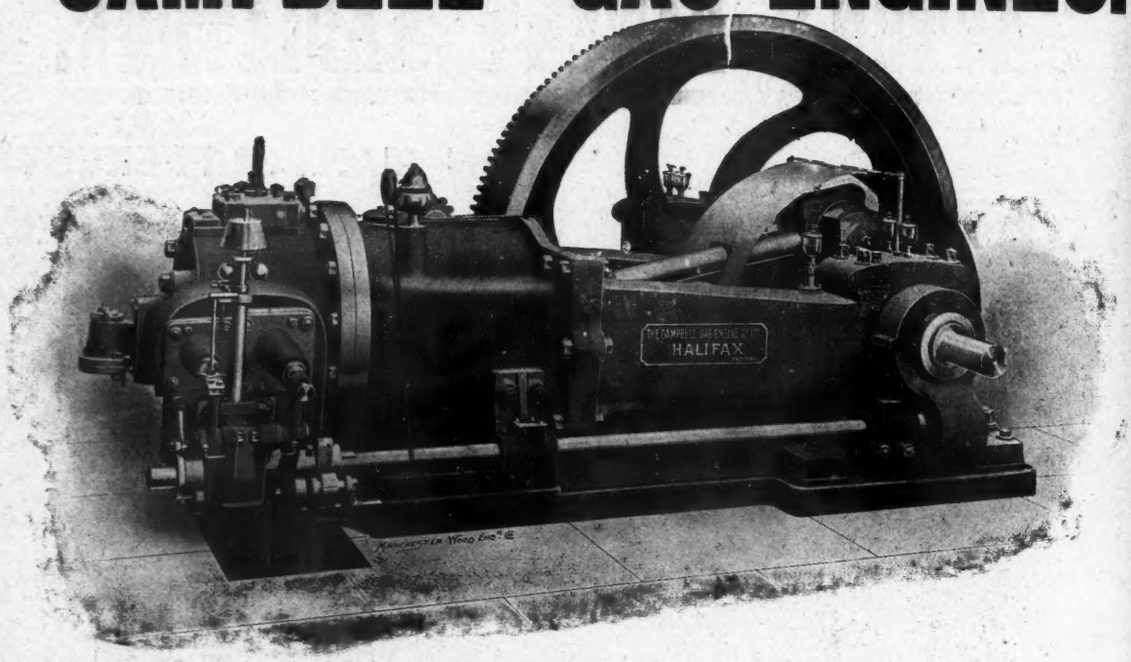

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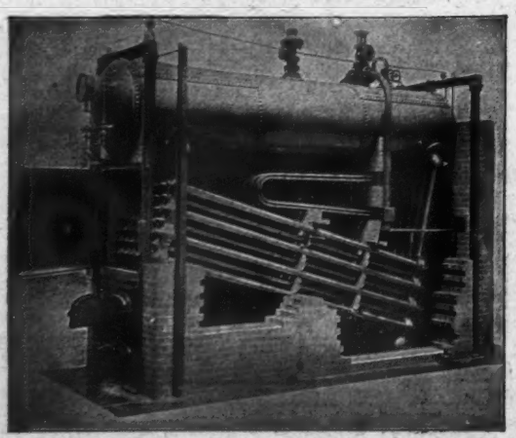

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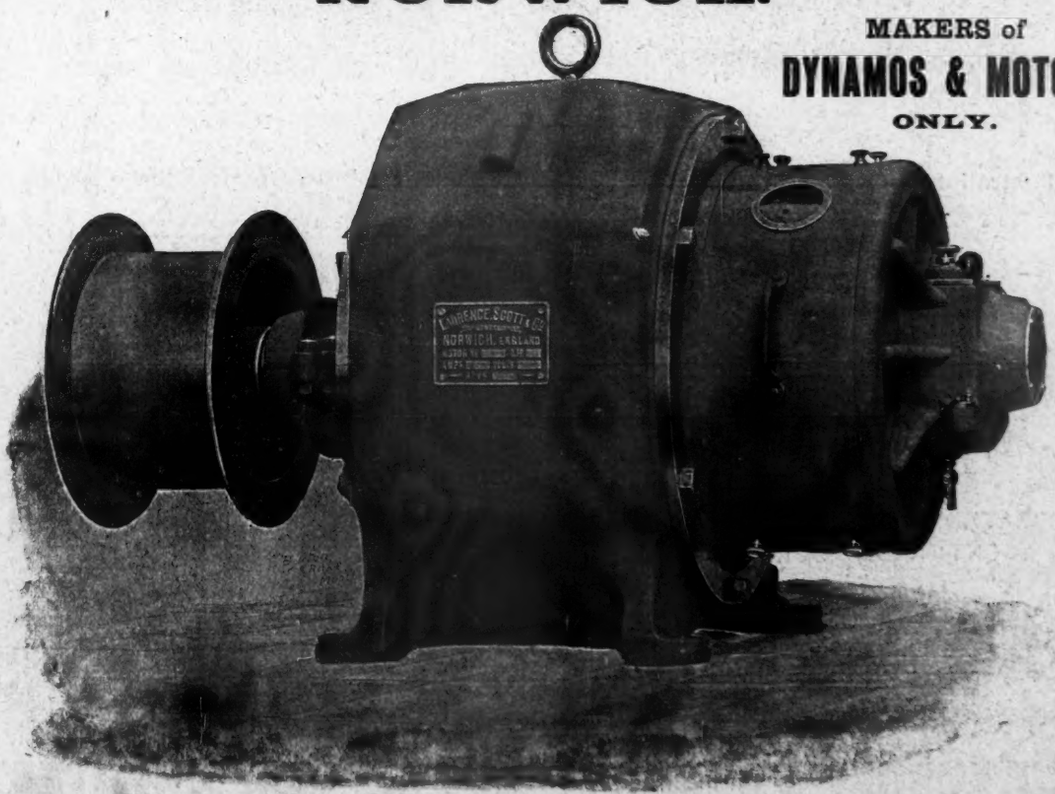

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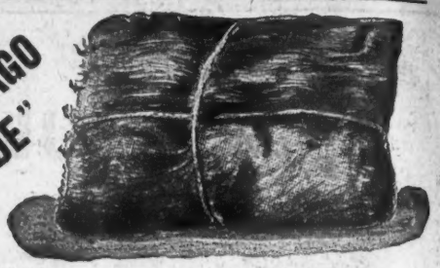

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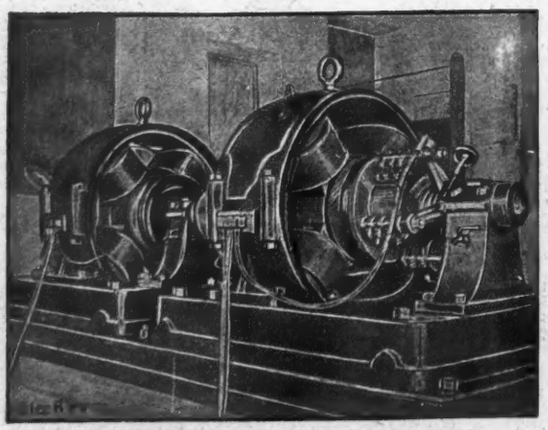

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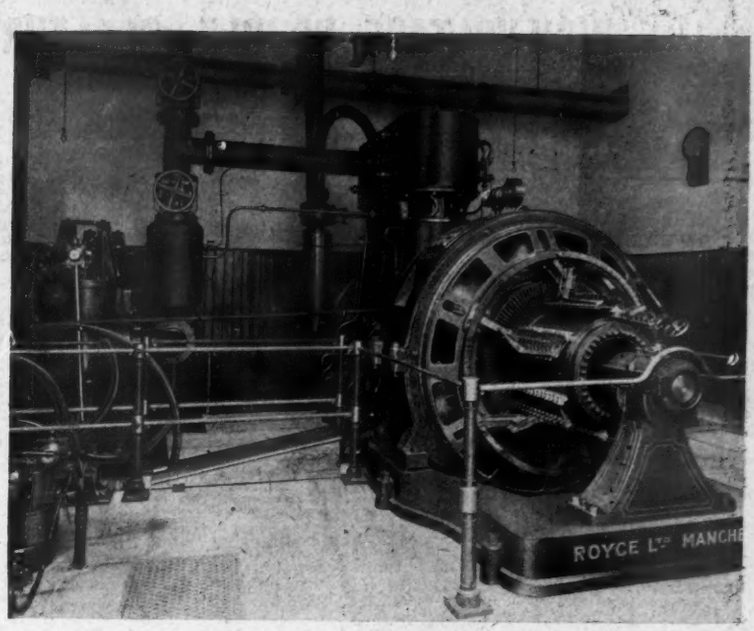

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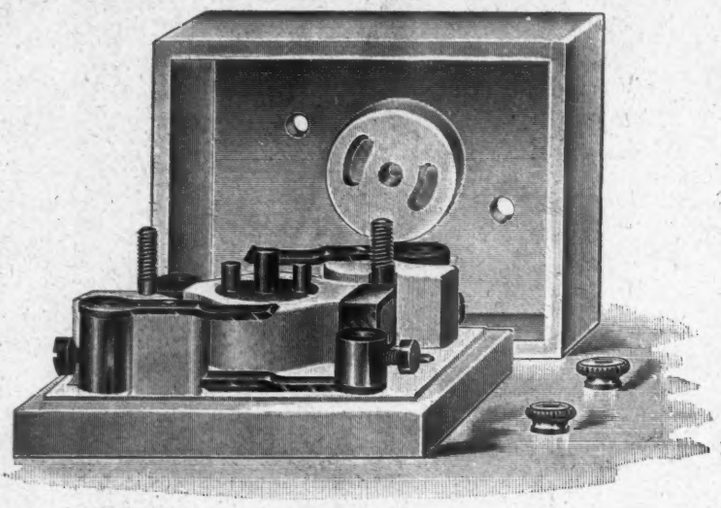

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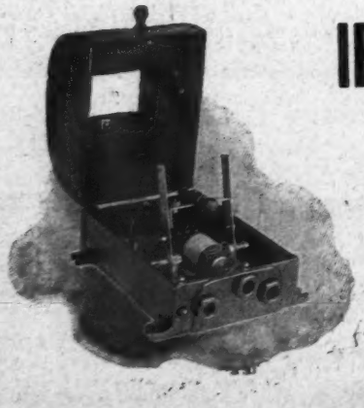

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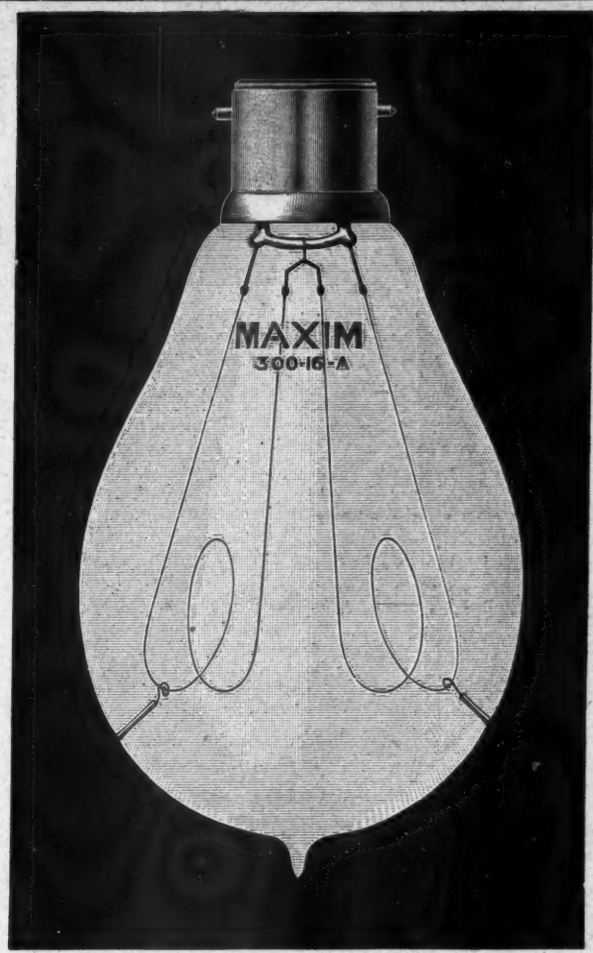

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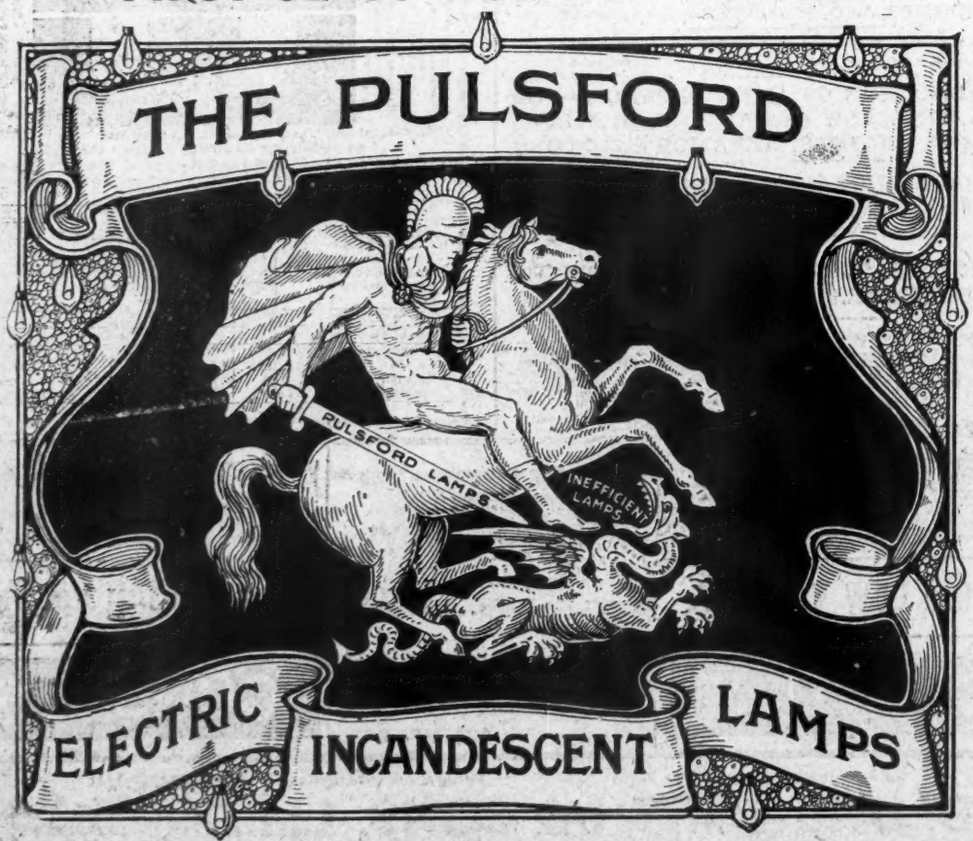

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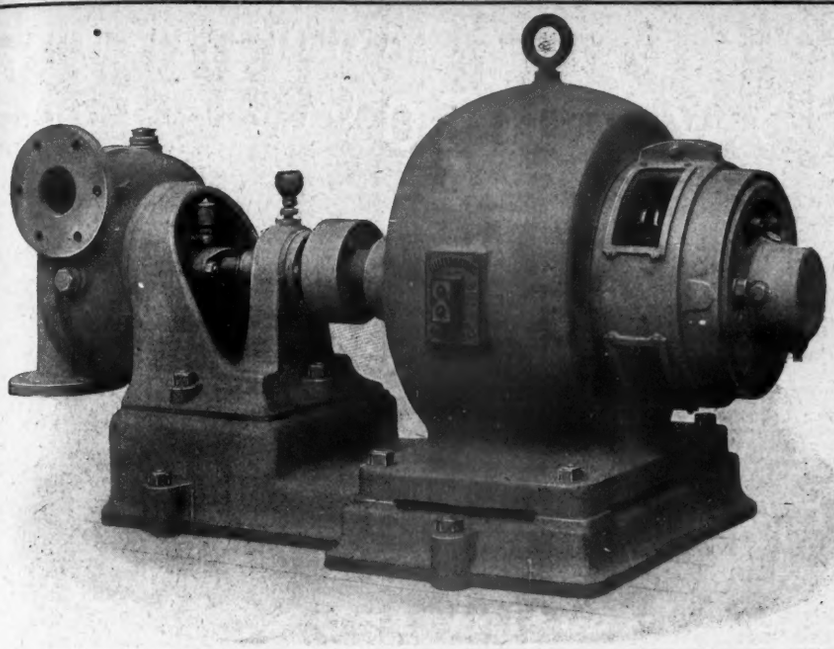

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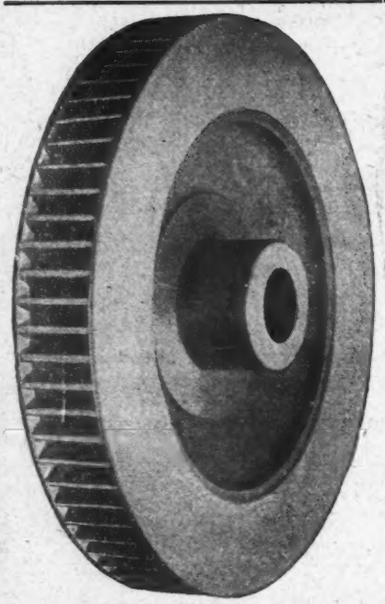

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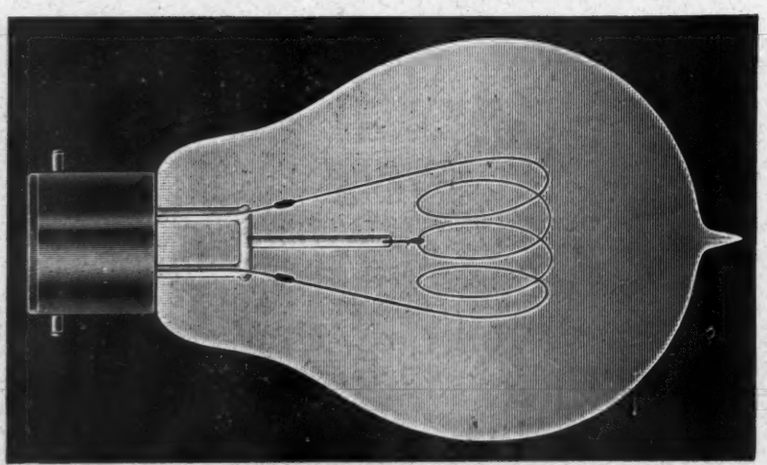

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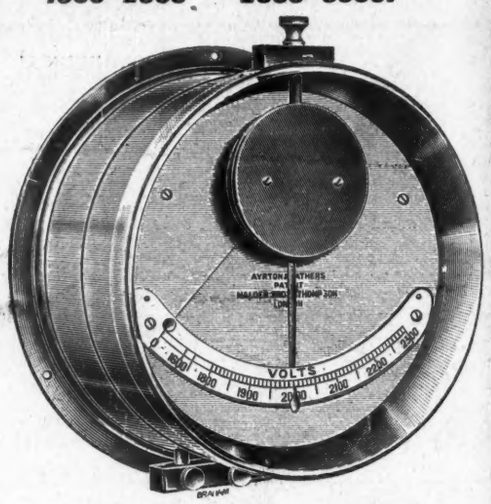

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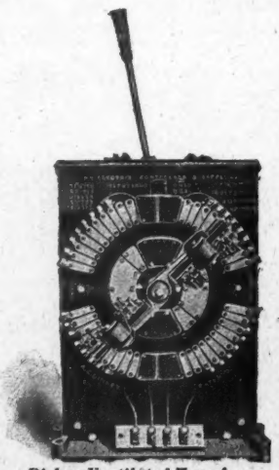
We Claim the following Advantages:—



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4. Magnetic blow-out upon all sizes.
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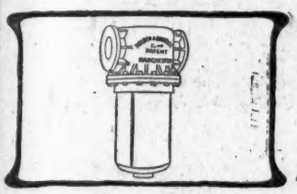

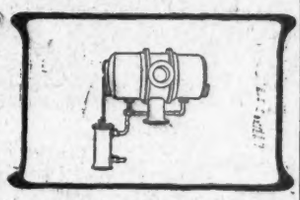

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The Corporation do not bind themselves to accept the lowest or any Tender.

R. BEATTIE NICHOLSON,
Town Clerk.

Town Clerk's Office,
Lowestoft,
December 12th, 1902. 219

BURGH OF PARTICK.

ELECTRICITY DEPARTMENT.

Arc Lamp Columns, Arc Lamps, Mains, &c.

THE TOWN COUNCIL OF THE BURGH OF PARTICK is prepared to receive Tenders for the following :—

Contract 11A.—200 Arc Lamp Columns, Arc Lamps, Fittings, &c.
,, 11B.—Supply, Laying and Jointing of necessary Cables, Feeders, Joint Boxes, &c.

Specifications and Forms of Tender may be obtained from Mr. H. B. MAXWELL, A.M.I.E.E., Burgh Electrical Engineer, Mauldslie Street, Partick, on payment of One Guinea, which will be returned on receipt of a *bona fide* Tender. Sealed Tenders endorsed "Dust Destructor and Electricity Supply, Tender for Contract No. 11A or 11B," to be lodged with the undersigned not later than 12 o'clock noon on Tuesday, January 6th, 1903.

The Council do not bind themselves to accept the lowest or any Tender.

JAS. DONALDSON,
Town Clerk.

97, West Regent Street,
Glasgow. 256

Official Notices.—*Continued.*

SWANSEA HARBOUR TRUST.

To Electrical Engineers and Contractors.

THE SWANSEA HARBOUR TRUSTEES invite Tenders for the wiring and supply of Sundry Fittings for electric lighting at the New Harbour Offices.

Conditions, Specification and Form of Tender may be obtained of the undersigned on payment of £2 2s., which will be returned on receipt of a *bonâ fide* Tender.

Tenders, sealed and marked outside "Tender Electric Lighting," should be delivered to the undersigned at the Harbour Offices, Swansea, not later than 10 a.m. on THURSDAY, 8th JANUARY, 1903.

The Trustees do not bind themselves to accept the lowest or any Tender.

TALFOURD STRICK,
Clerk.

Harbour Office, Swansea,
16*th December*, 1902. 311

METROPOLITAN BOROUGH OF STEPNEY.

Tenders for Steam Dynamo.

THE ELECTRICAL COMMITTEE of the Stepney Borough Council invite Tenders for the supply and erection at their Generating Station, Osborn Street, of One 500-KW. Combined Steam Engine and Multipolar Direct-current Dynamo, the Engine to be of the Vertical High-speed Reciprocating type.

Copies of the Specification can be obtained on application to the undersigned on payment of a deposit of £5 5s., which will be returned on receipt of *bonâ fide* tenders.

Tenders must be delivered, addressed to the Chairman of the Electrical Committee, 27, Osborn Street, Whitechapel, and endorsed "Tender for Steam Dynamo," not later than 12.0 noon on THURSDAY, JANUARY 15th, 1903.

The Council do not bind themselves to accept the lowest or any tender.

ARTHUR WRIGHT,
Consulting Engineer.

27, Osborn Street,
Whitechapel, E. 271

BOROUGH OF BARROW-IN-FURNESS.

ELECTRICITY DEPARTMENT.

Contract No. II.

THE CORPORATION are prepared to receive Tenders for the supply and erection of :—

(A.)—Two 250-KW. Engines and Generators.
(B.)—Generators and Traction Feeder Switchboards and Board of Trade Panel.
(C.)—Steam and Exhaust Pipes.

Complete Specifications and Forms of Tender may be obtained from the undersigned after the 10th inst., on payment of a deposit of Two Guineas, which will be returned on receipt of a *bona fide* Tender.

Tenders, addressed to the Chairman, Electricity Committee, and endorsed "Tender for Contract No. II., Section A, B or C," to be delivered at my office not later than 12 noon on MONDAY, JANUARY 5th, 1903.

The lowest or any Tender not necessarily accepted.

By Order,
C. F. PRESTON,
Town Clerk.

Town Hall,
Barrow-in-Furness.
December 2nd, 1902. 142

[Continued on *Page* 14.]

Official Notices.—*Continued.*

BOROUGH OF SOUTHEND-ON-SEA.

TO ELECTRICAL CONTRACTORS.

THE CORPORATION invite Tenders for the Wiring and Supply of Fittings for lighting by Electricity the Municipal Buildings and Institute, Clarence Road, Southend-on-Sea.

Particulars and Specification may be obtained upon application to Mr. W. E. J. HEENAN, M.I.E.E., Borough Electrical Engineer, Southend-on-Sea (upon deposit of cheque for 10s. 6d., which will be returned on receipt of a *bona fide* Tender).

Sealed Tenders, endorsed "Electric Lighting — Municipal Buildings," to be delivered at my office before 12 o'clock noon on Tuesday, the 6th day of January, 1903.

The Corporation do not bind themselves to accept the lowest or any Tender.

By order,
WILLIAM H. SNOW,
Town Clerk.

Southend-on-Sea,
20th December, 1902. 335

ESSEX AND COLCHESTER HOSPITAL.

THE COMMITTEE invite tenders for wiring and fittings for the electrical lighting of the Hospital buildings.

Persons desirous of tendering may inspect the plans between 10 and 12 a.m., and on payment of one guinea (which will be returned on receipt of a *bonâ fide* tender) obtain specifications from the Borough Electrical Engineer, Stanwell Street, Colchester.

Sealed tenders, endorsed "Tender for Wiring," to be addressed to the Secretary, The Hospital, Colchester, and to be sent in not later than Saturday, 17th January, 1903.

The Committee do not bind themselves to accept the lowest or any Tender.

By order,
C. L. BECHER,
Secretary.

December 26th, 1902. 339

CITY OF CANTERBURY.

BOROUGH ASYLUM.

Tenders for Electric Tell-Tales, Clocks and Bells.

THE ASYLUM COMMITTEE invite Tenders for a system of Electric Tell-Tales, Clocks and Bells at the Borough Asylum, Canterbury.

Copies of Specification and Conditions can be obtained upon application to the Borough Electrical Engineer, Electricity Works, Canterbury.

Tenders to be sent to the undersigned, marked "Tenders for Electric Clock, &c.," on or before 10 a.m. on THURSDAY, JANUARY 1st, 1903.

The Committee do not bind themselves to accept the lowest or any Tender.

By Order,
HENRY FIELDING,
Town Clerk.

Town Clerk's Office,
Canterbury,
December 17th, 1902. 300

Official Notices.—*Continued.*

STALYBRIDGE, HYDE, MOSSLEY & DUKINFIELD TRAMWAYS & ELECTRICITY BOARD.

Contracts Nos. 8 and 9.

THE BOARD are prepared to receive Tenders for the supply, delivery, laying, erection and connecting-up, &c., of the following :—

CONTRACT No. 8.

Section A.—High Tension Cables.
Section B.—Low Tension Cables, Telephone and Test Wires, &c.

CONTRACT No. 9.

Section A.—Extra High Tension Switchboards for Main Generating Station and Four Sub-Stations.
Section B.—Low Tension Switchboards.

Tenderers are at liberty to tender for any one or all of the Sections but not part of a Section.

Specifications and Forms of Tender may be obtained from the undersigned on making a deposit of One Guinea in respect of each Contract, which amount will be returned on receipt of a *bonâ fide* Tender.

Early application for Specifications is desirable as only a limited number will be given out.

Tenders are to be on the prescribed Form, accompanied by a further deposit of Five Guineas (which amount will be returned to those whose Tenders are not accepted), together with the Specification and General Conditions intact, sealed and endorsed "Contract No. 8," or "Contract No. 9," as the case may be, and delivered to the undersigned on or before MONDAY, JANUARY 5th, 1903.

The Board do not bind themselves to accept the lowest or any Tender.

FRANK SCHOFIELD,
Clerk to the Board.

Town Hall, Stalybridge,
December 8th, 1902. 166

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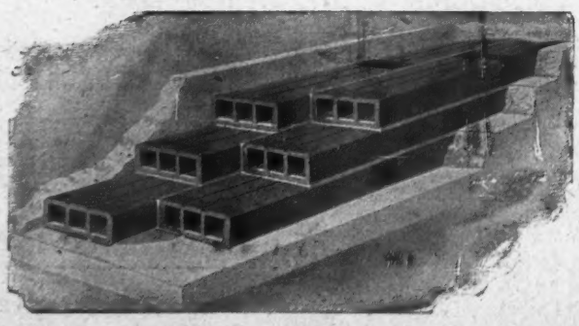

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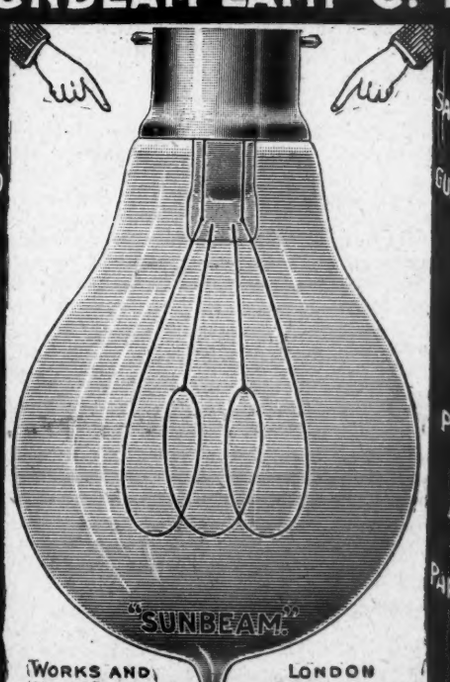
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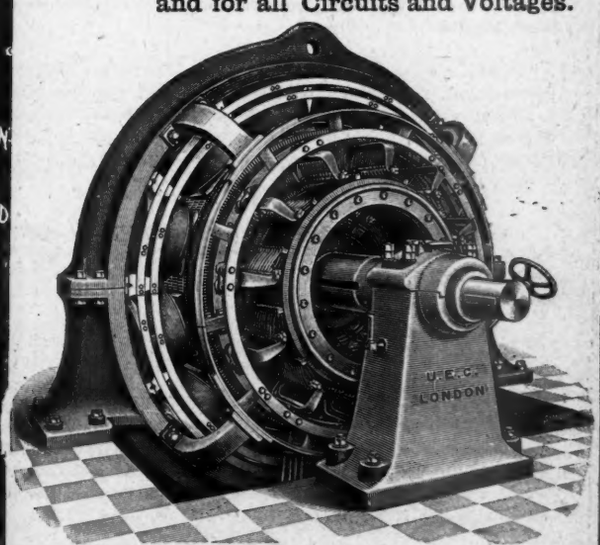

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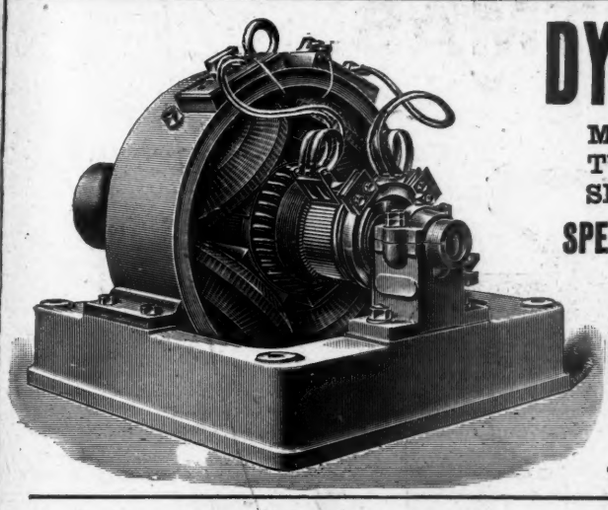

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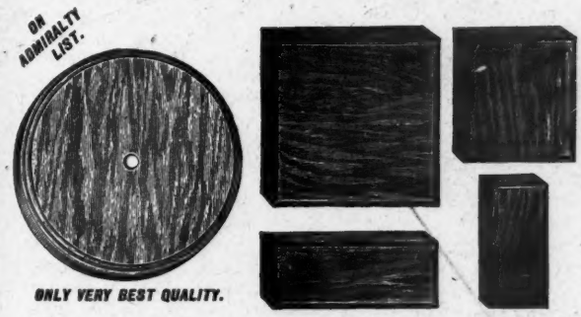

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"ELECTRICAL REVIEW."

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of any Electrical Industrial Paper in Great Britain.

SITUATIONS VACANT.

If letters are not to be delivered to certain firms or individuals (if known), instructions to that effect should be sent to the Manager of the ELECTRICAL REVIEW, who will do his best to carry out such instructions. Letters of applicants cannot in such cases be returned to them, nor can the names of Advertisers using a number or a *nom de plume* in any way be disclosed.

Original Testimonials should never be sent.

SENIOR ELECTRICAL ENGINEER.

GIBRALTER.

THE SANITARY COMMISSIONERS OF GIBRALTAR require the services of a Senior Electrical Engineer.

Salary £300 per annum.

Six month's probation; three months' notice thereafter from either side to determine the appointment.

Free passage out and half pay during the passage.

The selected candidate will be required to pass a strict medical examination before appointment.

The engineer who is appointed will be required to share with a qualified assistant electrical engineer the following duties among others:—

1. The generation and supply of continuous and alternating current for lighting and power purposes.
2. The maintenance and economic working of the generating station, the sub-stations, the mains, &c.
3. The superintendence of the installation of lights, motors, &c., in consumers' premises, and incandescent, arc, and Nernst lamps in streets.
4. The superintendence of the erection of additional plant by contractors.

Candidates are to state in their applications, age, full particulars of experience, date when they are prepared to commence their duties, and to forward *copies* of testimonials, with names and addresses of references, of whom enquiries can be made as to capabilities and characters.

Applications, &c., are to be delivered to the undersigned on or before Tuesday, the 20th January, 1903.

WM. WALLACE COPLAND,
Secretary and Engineer.

Sanitary Commissioners' Office,
Gibraltar, 10*th December*, 1902. 269

BOROUGH OF EASTBOURNE.

Electricity Department.

APPLICATIONS are invited for the post of Shift Engineer. Candidates must have had a good theoretical electrical and mechanical training, and be accustomed to alternating station practice. Age not less than 23. Salary £104 per annum. Applications stating age, experience, and when could take up duties, together with copies of not more than three testimonials, to be sent to the undersigned on or before Monday, the 5th day of January, 1903.

J. K. BRYDGES,
Borough Electrical Engineer.

Electricity Works,
Eastbourne, 301

BOROUGH OF GRAVESEND.

Electricity Works.

WANTED a Jointer used to three-core and triple concentric mains; must be thoroughly capable; wages 36s. per week. Applications in candidate's own handwriting accompanied by three references, stating age and experience to be sent to the undersigned on or before December 27th.

C. FRED. McINNES,
Electrical Engineer.

Electricity Works,
Gravesend. 278

(Continued on next page.)

SITUATIONS VACANT.—*Continued.*

COUNTY BOROUGH OF CROYDON.

CROYDON MENTAL HOSPITAL.

Appointment of Working Mechanical Electrical Engineer.

NOTICE IS HEREBY GIVEN that the Lunacy Visiting Committee of the County Borough of Croydon are prepared to receive Applications from persons between the age of 25 and 35, for the above appointment.

The wages will be 35s. per week, with house, rates and taxes free, and water. Applicants must have had experience in the running of electrical plant in a large public institution, and the person appointed will be required to do his own repairs.

Applications in candidates' own handwriting, to be made on forms to be obtained at my office, to be sent to me with three copies (not originals) of testimonials of recent date, not later than Tuesday, December 30th, 1902, endorsed "Working Electrical Engineer."

(By Order)
ALBERT C. GOWER,
Clerk to the Visiting Committee.

Town Hall, Croydon,
December 15th, 1902. 274

HORNSEY DISTRICT COUNCIL.

THE HORNSEY DISTRICT COUNCIL require the services of the following, in connection with their Electric Lighting Station at Hornsey, viz. :—

A Chief Assistant Electrical Engineer at a salary of £2 10s. per week.
An Electrician-in-charge at a salary of £2 per week, and
A Junior Electrician-in-charge at a salary of £1 10s. per week.

Application in candidate's own handwriting, stating age and previous experience, and accompanied by copies of not more than three testimonials of recent date, should be forwarded to me not later than Saturday, 10th January, 1903, endorsed on the outside, "Chief Assistant Electrical Engineer," "Electrician-in-charge," or "Junior Electrician-in-charge," according to the position for which application is made.

E. J. LOVEGROVE, M.Inst.C.E.,
Engineer and Surveyor to the Council.

Council's Offices,
Southwood Lane,
Highgate, London, N.,
December 13th, 1902. 249

DUNDEE TOWN COUNCIL.

Electrical Department.

THE DUNDEE TOWN COUNCIL are prepared to receive Applications for the post of City Electrical Engineer, at a salary of £400 per annum.

Applicants must be fully qualified Electrical and Mechanical Engineers, competent to advise upon and superintend, if required, future extensions of the electrical undertaking, including the tramways.

Memorandum of duties may be had on application to the undersigned, with whom applications, stating age and qualifications, together with copies of recent testimonials, must be lodged (marked on the outside "Electrical Engineer,") not later than Saturday, December 27th, 1902.

THOS. THORNTON,
Town Clerk.

City Chambers, Dundee,
December 10th, 1902. 221

CITY AND COUNTY BOROUGH OF BELFAST.

ELECTRIC DEPARTMENT.

THE GAS and ELECTRIC COMMITTEE of the Belfast Corporation invite applications for the position of "Engineer-in-Charge," at a salary of £2 5s. per week.

Applicants must have held a similar position in a low tension station with batteries.

Applications stating age, experience, accompanied by copies of not more than three recent testimonials to be sent to the undersigned, not later than the 29th December, 1902.

VICTOR A. H. M'COWEN,
City Electrical Engineer.

Belfast. 262

SITUATIONS VACANT.—*Continued.*

COUNTY BOROUGH OF ROTHERHAM.

Corporation Electric Tramways.

THE TRAMWAYS COMMITTEE are about to appoint a Tramway Manager. Salary £150 per annum.

A Ticket Inspector at 32s. per week.

A Car-shed Foreman at 40s. per week.

A Clerk (with previous experience in Tramway work) at 35s. per week.

Intending applicants must send their applications to me on or before Monday, the 5th January, 1903.

Such applications must contain the full name and address of the applicant, his age (which must be between twenty and forty), present occupation, previous experience in tramway work, whether married or single, and two references or copies of two recent testimonials must be sent.

Canvassing is strictly prohibited and will disqualify.

By Order,
H. HAMPTON COPNALL,
Town Clerk.

Town Hall, Rotherham,
December 19th, 1902. 325

Where Advertisements are to be answered to a given number, letter, or *nom de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.

Cheap Prepaid Advertisements are inserted under this heading at the rate of One Penny Per Word (minimum 1s.). Three Consecutive Insertions for the price of two.

Box Number and ELECTRICAL REVIEW address count as seven words.

ACCUMULATORS.—Wanted a Gentleman well up in the accumulator business, for estimating, making drawings, and to travel occasionally. Salary £150—£200. Must have several years' references from accumulator companies.—Write in first instance, Box 688, Willing's, 125, Strand, W.C. 333

ARC Lamp Trimmer wanted, Crompton & Gilbert open type.—State experience and wages.—"ENGINEER," Electricity Station, Stockport. 331

ASSISTANT Draughtsman required, thoroughly conversant with small motor details, for London factory. Applicants must have had workshop experience, theoretical training, and previous drawing office practice. No applications will be considered unless accompanied by copies of testimonials and a full detailed statement showing experience and length of service in former posts. Commencing salary 40/- weekly.—Reply to No. 294, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 294

CABLE Works on the Continent wants competent Foreman to manage rubber department; must thoroughly understand the treatment of rubber for first-class cable. State wages and give references where previously employed, in strict confidence.—Apply to 273, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 273

ELECTRICAL Trades Union, reg. No. 640, telephone No. 623 Central.—Employers requiring competent workmen can obtain same at short notice by the use of the telephone or post, to A. EWER, Club Union Buildings, Clerkenwell Road, E.C. 9791

ELECTRICAL Engineering.—Vacancies for one or two Premium Pupils, also for three or four Fitters.—Apply HEADLEY'S ELECTRICAL WORKS, Moresk Mills, Truro. 329

ENGINEER wanted to superintend electric lighting installations for a well known Midland firm.—Apply by letter, stating age, salary required, and experience, especially in the management of workmen.—326, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 326

(Continued on next page.)

SITUATIONS VACANT.—*Continued.*

EXPERIENCED Salesman for large electrical business, Manchester district. State age, salary, &c.—337, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 337

MIDDLE-AGED Workman to take charge of small Workshop, armature repairs, also used to lathe, vice, &c.—Write age, experience and salary to CORLETT ELECTRICAL ENGINEERING Co., Wigan. 345

THE Norwich Electricity Co. have a vacancy for a Shift Engineer. Must have had good electrical and mechanical training, and some experience in a station.—Apply stating age and giving full particulars, Duke Street, Norwich. 283

TRAVELLER wanted, having good connection on East, South, and West Coast. Must reside in London.—State full particulars as to experience, terms, and when disengaged, to TUCKER AND Co., Sampson Road North, Birmingham. 267

WANTED.—First-class Man to run arc lamp department in large works; would be required to answer all departmental enquiries, fix prices and be responsible for quality of work sent out. No applications considered unless accompanied with fullest particulars.—213, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 213

WANTED. — Energetic Young Man to push the sale of a Special Incandescent Electric Lamp, one acquainted with the trade preferred, London and suburbs, small salary and commission. — Apply, 201, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 201

WANTED, an English Technical Translator, thoroughly conversant with French and German.— Write giving age, training, experience, references, and salary required, to 334, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 334

WANTED.—Cable Jointer; must have had experience with rubber and paper cables, and be capable of taking charge of a gang, both for drawing cable into conduit and laying mains on the solid system.—Apply by letter only, stating age, experience and wages required, with copies of testimonials, to THE NATIONAL ELECTRIC SUPPLY Co., LTD., Bushell Street, Preston. 327

WANTED.—A young Engineer to look after the erection of overhead equipment of tramways; must have had some experience on similar work. State age, experience and salary required. Also young Engineer to look after the construction of electric tramway track.—328, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 328

WANTED, services of a gentleman who has good knowledge of electric traction and electric lighting, also of accounts and dissection thereof, and with literary ability, for the staff of a technical journal.—Apply stating experience and salary required to 244, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 244

WANTED.—Switchboard Attendant in a central station of 2000-KW. capacity, situated in Metropolitan area. Applicants must have had practical experience of the three-wire system, possesed of theoretical electrical knowledge and be prepared to work consecutively with two others on an eight-hour shift, and reside within an approved distance from the works. Preference will be given to one also having experience of high tension continuous current working. Commencing wages 30s. per week. —Applications stating age, experience, &c., with copies of testimonials, to 341, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 341

WANTED Immediately, for private generating plant, a second Man used to direct coupled engines and dynamos.—Apply, giving particulars as to experience, age, wages, &c., to 257, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 257

SITUATIONS VACANT.—*Continued.*

WANTED by large shipbuilding works, a Mechanical Draughtsman capable of drawing out all details involved in the conversion of shipyard and engine works tools from belt to direct-driving by electric motors. Must have good all-round experience of machine designing and especially of high-speed toothed gearing on modern lines. — Write full particulars of qualifications, age, salary expected, &c., to 340, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 340

WIREMAN wanted. — Two capable young men, competent repairing telephones, Jandus arc lamps, &c.; permanent situation to good men.—Apply stating age, experience and salary required, "ELECTRICIAN," Frodingham Iron and Steel Co., *viâ* Doncaster. 342

SITUATIONS WANTED.

Where Advertisements are to be answered to a given number, letter, or *nom de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.

Cheap prepaid Advertisements are inserted under this heading at the rate of One Penny Per Word (minimum 1s.). Three Consecutive Insertions for the price of two.

Box Number and ELECTRICAL REVIEW address count as seven words.

ADVERTISER (30) requires situation as Electrician to take charge of plant.—210, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 210

ELECTRICAL and Mechanical Engineer requires situation in charge of plant on gentleman's estate. Long experience.—Address 291, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 291

ELECTRICAL Engineer will shortly be open to engagement. Experienced in the construction and running of traction and lighting plants, and used to the control of large numbers of hands on contract works. First-class references.—Apply 293, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 293

ELECTRICAL Engineer requires appointment as Assistant or Shift Engineer; practical experience in large lighting station, and three years college.—338, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 338

ELECTRICIAN (24) wants job. Own casing, Simplex, telephones, bells; references.—"C. F.," 6, Eton Street, Richmond, Surrey. 292

ELECTRICIAN, competent, seeks employment; lighting, bells, telephones; town or country.—"ELECTRICIAN," 14, Shrubland Road, Dalston. 318

FITTER Wants Situation, used to erecting and running of private electrical plant, steam, gas, or oil accumulators, wiring, &c.—W. BARTER, Cadmore, High Wycombe. 196

GENERAL Foreman (disengaged) requires situation over dynamo and motor manufacturing, both alternating and continuous current, 12 years' experience.—Address, 246, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 246

IMPROVER (18), electrical student City and Guilds, theoretical and technical training and sub-station experience, seeks appointment in works or power station; London preferred.—207, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 207

INCANDESCENT Electric Lamp Making.—A Works Manager, understanding all processes and latest methods from filament making to dispatching, will, in a few weeks, be open to offers for a similar position; long experience. Replies treated confidential.—Apply, 254, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 254

(Continued on next page.)

SITUATIONS WANTED.—*Continued.*

INSTRUMENT Maker (age 35), seeks work; good turner, fitter, pivotter, &c.; fair electrical knowledge.—"H. D.," 6, Northampton Road, Clerkenwell, E.C. 324

TO Consulting Engineers.—Engineer (29), with electric generating station experience, lighting and traction, good mechanical draughtsman and erector, seeks position as Assistant.—322, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 322

WIREMAN'S Assistant seeks situation, 7½d., town or country.—BLACK, 42, Mall Road, Hammersmith. 303

YOUNG Gentleman (16) requires Apprenticeship in electrical and mechanical engineering works; premium.—CLARSON, "The Mount," Tamworth. 181

AGENCIES.

Where advertisements are to be answered to a given number, letter, *nom de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.
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A FIRM of electrical engineers in London desire Agencies for electrical appliances generally.—247, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 247

AGENTS in all important towns wanted for sale on commission of British made up-to-date Direct Current Motors.—Applications from established firms only will be entertained.—"B.," Box 535, SMITH'S ADVERTISING AGENCY, 100, Fleet Street, E.C. 309

ELECTRIC Welding.—Gentleman with large connection wishes to represent firm of electrical welding machinery manufacturers.—Apply, 200, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 200

GENTLEMAN (26), shortly sailing for New Zealand wishes to represent first-class agencies in all electrical goods, motors, dynamos, batteries, cables and every kind of electrical accessory, gas and oil engines, fully conversant with commercial side of business, including estimating and managing every description of installation work.—332, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 332

FOR SALE.

TO ELECTRIC LIGHTING COMPANIES, ELECTRICAL ENGINEERS, AND OTHERS.

THE CORPORATION of the City of Dublin, being about to open their new Electricity Supply Works, are prepared to sell by private treaty, either as a whole or in separate lots, the Generating Plant now running in their existing works in Fleet Street, including five alternating current dynamos of 50, 150 and 200 kilowatts capacity, driven by slow speed horizontal engines, three sets of Brush arc lighting engines and dynamos; also sundry water-tube and Lancashire boilers.

A complete schedule of the plant for Sale, and the conditions of purchase, can be obtained from the Secretary to the Lighting Committee, Mr. FRED. J. ALLAN, 3, Cork Hill, Dublin; and the plant can be inspected by previous appointment with the City Electrical Engineer, Mr. MARK RUDDLE, at the Corporation Electricity Works, Fleet Street, Dublin. Tenders to be sent in not later than 24th January, 1903, addressed to "The Chairman Lighting Committee, 3, Cork Hill, Dublin." 259

FOR SALE.—*Continued.*

FOR Sale cheap, 1 H.P. 200-volt alternating current motor; one 1 H.P. 100-volt C.C. motor; one 100-watt dynamo; one ampere meter reading from 0 to 150. The above are all in perfect condition.—MILLINGTON & EVERITT, King's Parade, Cambridge. 289

PRIVATE House Plant, consisting of "Crossley's gas engine, 5½ H.P. Dynamo by Elwell-Parker, 32 E.P.S. Accumulators. Switchboard Wires, all equal to new. Price £100, or best offer.—Apply 513, New Chester Road, Rock Ferry, Birkenhead. 295

70-KW. Willans Siemens Steam Set, 285 amps. at 252 volts, 450 revs., in excellent condition, for sale, cheap.—Apply, WHEATLEY KIRK, PRICE & Co., 46, Watling Street, London, E.C. 323

BUSINESSES FOR SALE.

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ELECTRICAL Engineering Business for sale, London, W. Stock at valuation, about £300. Offices and workshop in good position at moderate rent.—Address 229, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 229

ARTICLES WANTED.

Where Advertisements are to be answered to a given number, letter, or *nom de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.
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ACCUMULATORS, Second-hand, any type, wanted; also lead peroxide, old copper cable, lamp tops, scrap metals, and every description of metallic dross purchased for cash, town or country.—Write, A. BROWN, 77, Lansdowne Road, Dalston, N.E. Telephone: 326, Dalston. 8534

GOOD second-hand, direct-coupled, 30 to 50-KW., 220 to 250 volts, continuous current Dynamo to high-speed Engine, 80 lbs. stop valve condensing.—Price and particulars to CORLETT ELECTRICAL ENGINEERING Co., Wigan. 344

PLATINUM, in any form and quantity, purchased at highest prices by DERBY & Co., 44, Clerkenwell Road, London. 6522

WANTED.—Oil Engine and Dynamo for 50 to 80 16-C.P. lamps.—MERCIER'S PATENTS, LTD., Salford. 343

WANTED.—Second-hand rubber tube making machine, suitable for half-inch to three-quarter inch tubes.—W. T. GARNETT AND Co., Barkerend Mills, Bradford, Yorks. 211

WANTED.—Electric Lamp Tops and Scrap Platinum.—EDEY AND Co., 29, Ludgate Hill, London. 238

1000 LAMPS, 8, 16, 25 and 32-C.P., 230 volts, for cash, trade.—320, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 320

(Continued on next page.)

MISCELLANEOUS.

Where Advertisements are to be answered to a given number, letter, or *nom de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.

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ACCUMULATOR CHARGING.—C. H. Cathcart & Co., having plant specially adapted for this purpose, charge cells of all sizes promptly, thoroughly and cheaply. Terms on application. Accumulators on hire for temporary lighting, experimental uses, &c.—3, Dorset Buildings, Salisbury Square, Fleet Street, E.C. (Telephone No. 266, Holborn). 7365

EPSTEIN Accumulator Plates for Storage Batteries are now supplied by the sole licensees and makers, W. O. ROOPER AND CO., Electrical Engineers, Stafford. 80

ACIDS for Accumulators.—Manufactured by H. N. MORRIS AND CO., Gorton Brook Chemical Works, Manchester. Largest suppliers to the electrical trade. 321

SEARCHLIGHTS for sale or hire.—JOHNSON & PHILLIPS, Victoria Works, Charlton, Kent. 3945

THE "PRACTICAL ENGINEER" Electrical Pocket Book and Diary for 1903, price 1s. 6d., postage 2d., contains 340 pages of valuable data, tables, &c., in handsome binding, with gilt edges, pocket, and elastic band.—TECHNICAL PUBLISHING CO., LIMITED, Whitworth Street, Manchester, and all Booksellers. 330

TO Manufacturers only (or their direct agents) supplying very light electromotors, suitable (or specially designed) for driving automobiles.—Makers' leaflet or card only, in first instance, to 236, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 236

TRANSLATIONS! Translations!—From and into all European languages of letters, pamphlets and books, commercial, technical, and literary. Private lessons and classes in modern languages; also by correspondence.—Apply for prospectus, Dr. LOUIS KORNITZER, 10, Ridley Place, Newcastle-on-Tyne. 306

WANTED.—Names and addresses of manufacturers of pole-finding paper; large sheets required.—336, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 336

S. AFRICAN Address: P.O. Box 3693, Johannesburg.

CONVEYING PLANT.

MAKERS:

Graham, Morton & Co. Ltd.

Works:—

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Mr. J. G. LORRAIN, M.I.E.E., M.I.M.E., &c.
Fellow of the Chartered Institute of Patent Agents.
Norfolk House, Norfolk St., London, W.C.
"PATENTEE'S HANDBOOK." Post Free on Application. 12

THE STIRLING BOILER CO., Ltd.,
2, ST. ANDREW SQUARE, EDINBURGH.
See Illustrated Advertisement last week.

GENERATORS, MOTORS, &c.
Telegrams: "Drehstrom," London.
LAHMEYER ELECTRICAL CO., LIMITED,
109—111, New Oxford Street London, W.C.
Telephone 3823 Gerrard.
See Advertisement in last issue, page Sup. 10.

INSTRUMENTS AND PLANT TESTED.
THE ELECTRICAL STANDARDIZING, TESTING AND TRAINING INSTITUTION.
(*Proprietors:* The Syndicate of Electrical Engineers, Ltd.),
ESTABLISHED 1889,
FARADAY HOUSE,
8 & 10, CHARING CROSS ROAD, LONDON, W.C.
Telephone No. 5043, Gerrard. *Telegraphic Address: "Standardizing, London."*
Standardizes and Tests Electrical Instruments.
Inspects and Certifies every kind of Electrical Plant and Materials.
Investigates and Reports upon Electrical Inventions.
Inspects Installations of Electric Wires and Plant on behalf of Architects, Householders, Manufacturers, Supply Companies, Fire Offices, &c.
Lets Private Experimenting Rooms, and offers every facility, with skilled assistance when desired, to Experimenters in Electrical Science.
A Scale of Fees will be sent on application to the SECRETARY.

ROSS, COURTNEY & CO. Ltd.,
ASHBROOK ROAD, LONDON, N.

WHITWORTH and BRITISH ASSOCIATION SCREWS AND NUTS
ALWAYS IN STOCK.
BRASS NUTS, SMALL REPETITION AND STAMPING WORK A SPECIALITY.
WE MAKE PROMPT DELIVERY A SPECIAL POINT
Quotations on receipt of Requirements.

ELECTRICAL REVIEW.

BINDINGS AND CASES.—Subscribers and others can have their half-yearly numbers bound handsomely in Black Cloth at the rate of 4s. per volume. Cases for binding are also supplied at 2s. 6d. each.—4, Ludgate Hill, London.

ILLUSTRATED. CLOTH, 10s. 6d. POST FREE.
POWER DISTRIBUTION
FOR
ELECTRIC RAILROADS.
By LOUIS BELL, Ph.D.
THIRD EDITION, REVISED and ENLARGED.
— CONTENTS —
Chap. I., Fundamental Principles.—II., The Return Circuit.—III., Direct Feeding Systems.—IV., Special Methods of Distribution.—V., Sub-stations.—VI., Transmission of Power for Sub-stations.—VII., Alternating Motors for Railway Work.—VIII., Inter-Urban and Cross Country Work.—IX., Fast and Heavy Railway Service.
H. ALABASTER, GATEHOUSE & CO.,
4, LUDGATE HILL, LONDON.

THE ELECTRICAL REVIEW.

CHEAP PREPAID ADVERTISEMENTS,

(Latest time for receiving 12 noon Thursdays).

Relating to Situations Vacant, Situations Wanted, Businesses Wanted, Businesses for Sale, Patents for Sale, Specific Articles of any kind Wanted, or for Sale or Exchange, are inserted at the rate of ONE PENNY Per Word (minimum 1s.).

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DISPLAYED ADVERTISEMENTS.

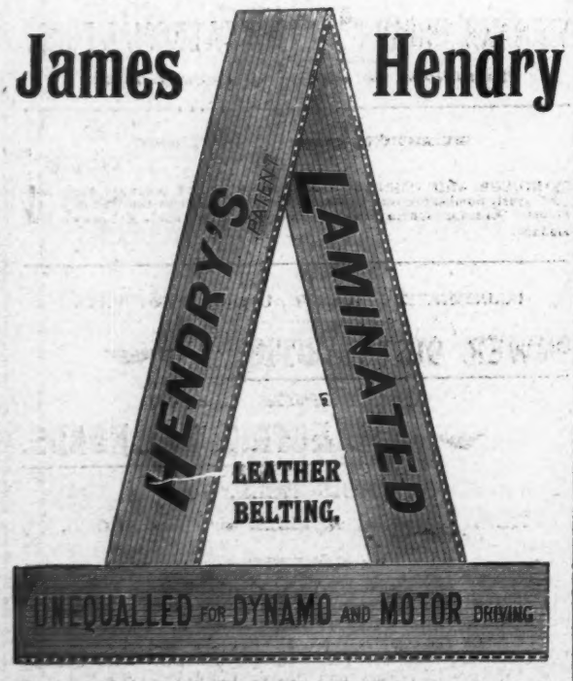
Advertisers will please note that NEW COPY and ALTERATIONS TO EXISTING ADVERTISEMENTS should reach here NOT LATER THAN MONDAY MORNING.

The "Electrical Review," is the recognised medium of the Electrical Trades,

AND HAS

BY FAR THE LARGEST CIRCULATION

OF ANY ELECTRICAL INDUSTRIAL PAPER IN GREAT BRITAIN.



Laminated Leather Works, BRIDGETON, **GLASGOW.**

ILLUSTRATED. CLOTH, 8s. POST FREE.

ELECTRICITY and its RECENT APPLICATIONS.

A Practical Treatise for Students and Amatures, with an Illustrated Dictionary of Electrical Terms and Phrases.

By EDWARD TREVERT

H. ALABASTER, GATEHOUSE & CO.,
4, Ludgate Hill, London.

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80 Illustrations. Cloth. Post Free. *2s. 6d.*

PHOTOGRAPHIC AND OPTICAL ELECTRIC LAMPS.

BY RANKIN KENNEDY.

A Treatise for Photographers, Photo-Electric Printers' Etchers and Engravers, and including Apparatus for Copying Purposes for Engineers and Architects.

The only work in existence treating on this special subject

H. ALABASTER, GATEHOUSE & CO.,
4, LUDGATE HILL, LONDON, E.C.

CLOTH. POST FREE. *7s. 6d.*

APPLIED MAGNETISM:

AN INTRODUCTION TO THE DESIGN OF ELECTRO-MAGNETIC APPARATUS.

By J. A. KINGDON, B.A.,

Formerly Math. Schol., Pem. Coll., Oxon.

75 ILLUSTRATIONS, MANY ORIGINAL; SEVEN TABLES.

CONTENTS.

Chap. I., General Principles of Magnetism; Chap. II., The Electromagnetic Units; Chap. III., Magnetomotive Force of Current; Chap. IV., Magnetic Traction; Chap. V., Generation of Electromotive Force; Chap. VI., Qualitative Magnetism; Chap. VII., The Alternator; Chap. VIII., The Dynamo; Chap IX., Magnets and Magnetic Leakage; Chap. X., Commutators and Collectors; Chap XI., Hysteresis and Heating of Armatures; Chap. XII., Alternating Magnetic Flux; Chap. XIII. Electromotors; Chap. XIV., Polyphase Currents and Rotary Fields; Chap. XV., Magnetic Measurements; Chap. XVI., Calculations in Inch Measures. Appendices:—I., Dimensions of Fundamental, Derived and Electromagnetic Units; II., Symbols and Formulæ. Index.

H. ALABASTER, GATEHOUSE & CO.,
4, LUDGATE HILL LONDON, E.C.

NOW READY.

Mounted on Linen, Post Free, 2s.

LIST OF ELECTRIC TRAMWAYS & RAILWAYS IN THE *UNITED KINGDOM.*

TO BE OBTAINED FROM
H. Alabaster, Gatehouse & Co.,
4, LUDGATE HILL, LONDON.

THE

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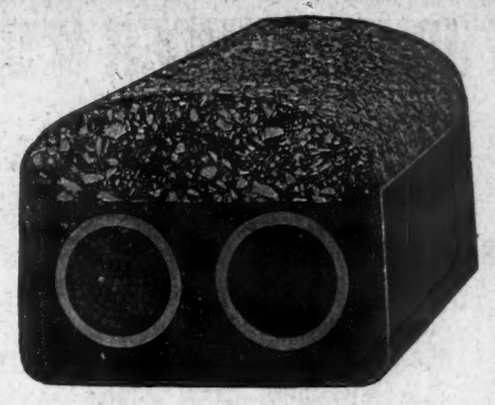

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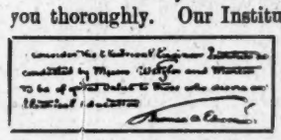

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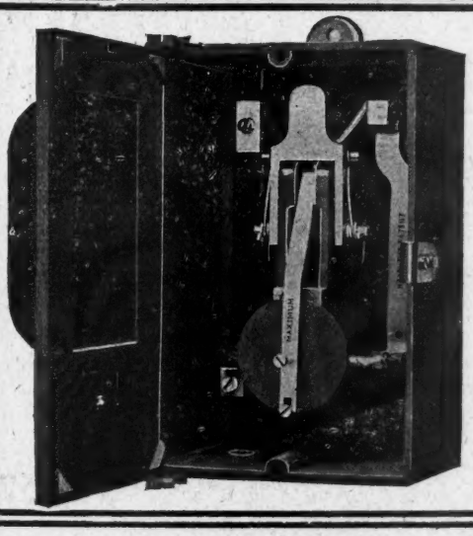

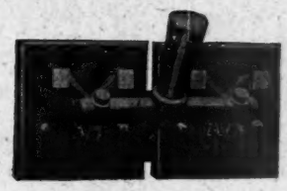

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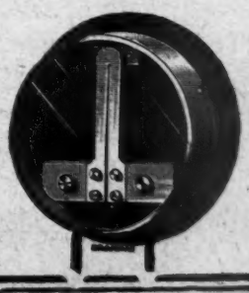

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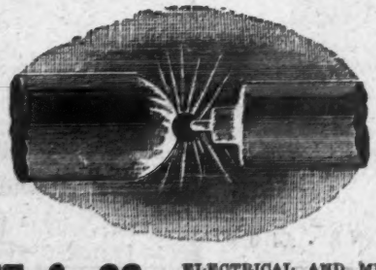

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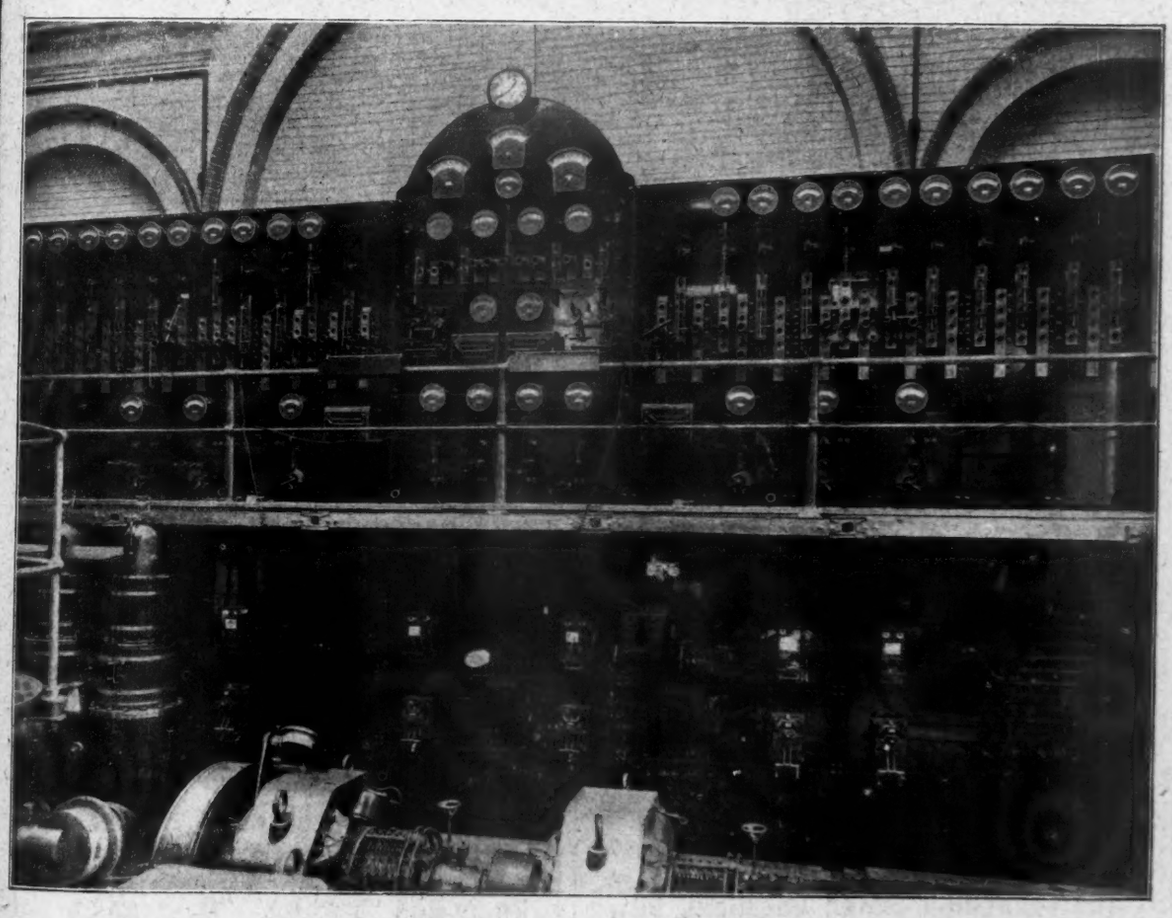

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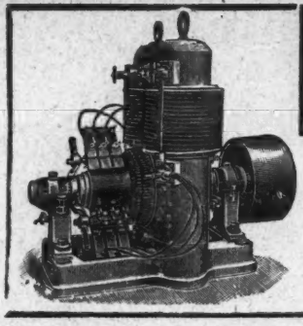

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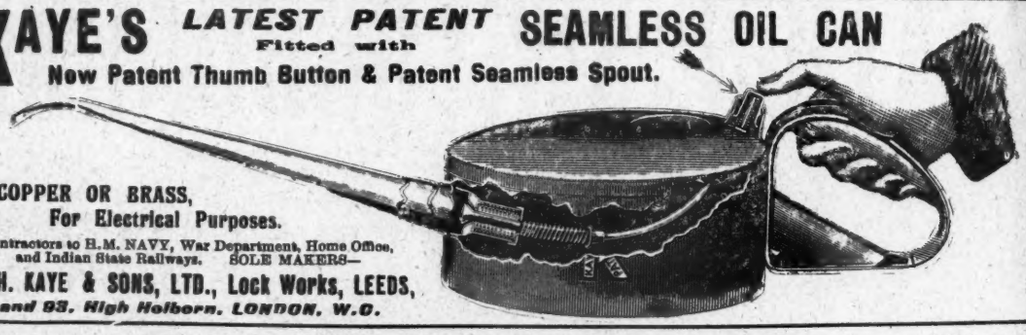

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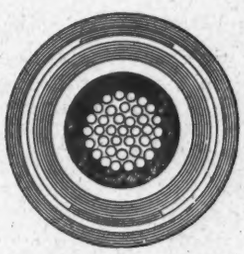

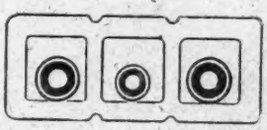

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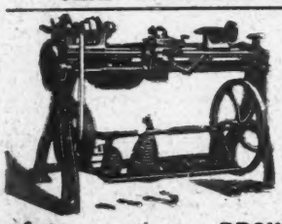

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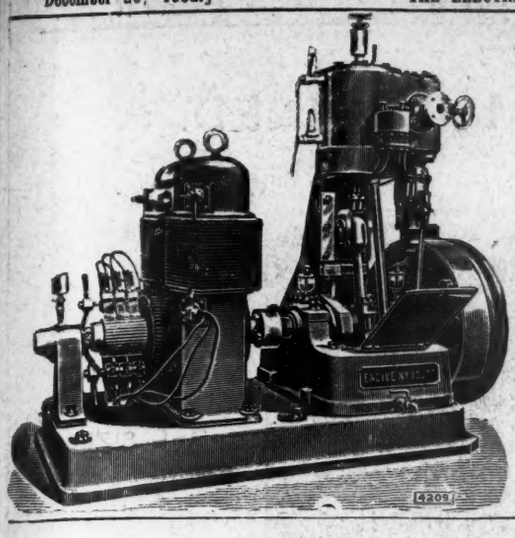

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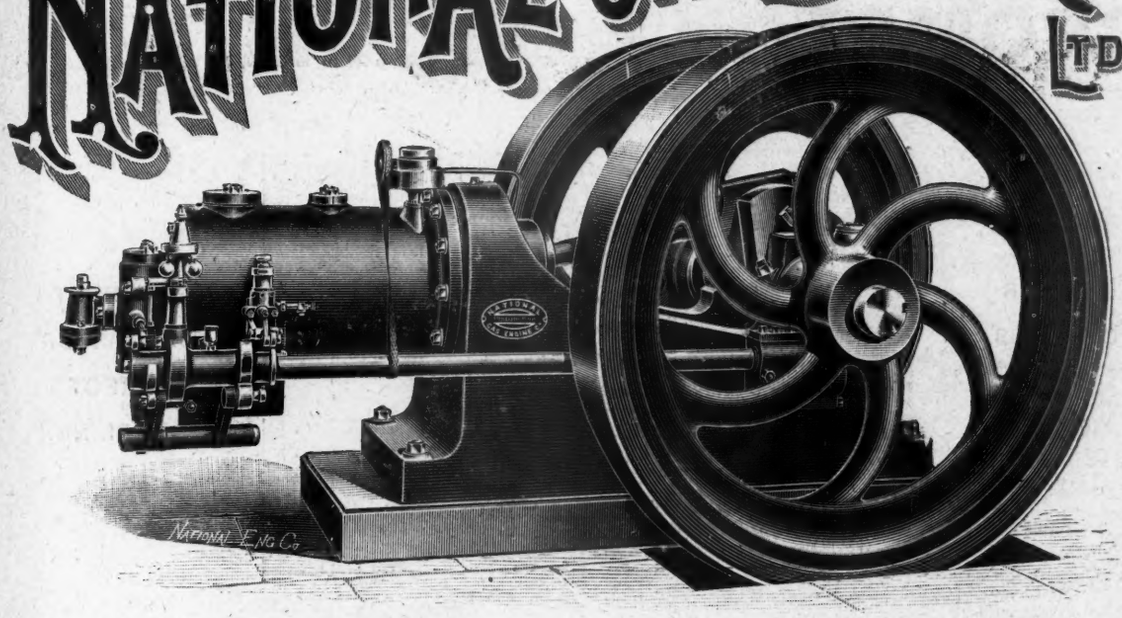

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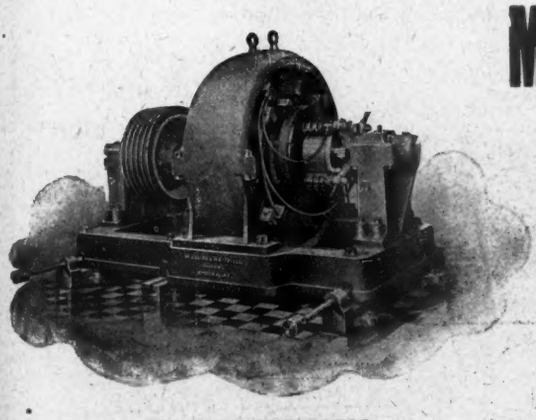

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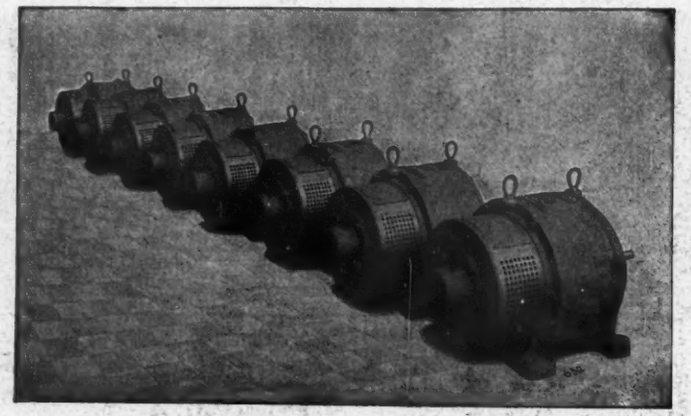

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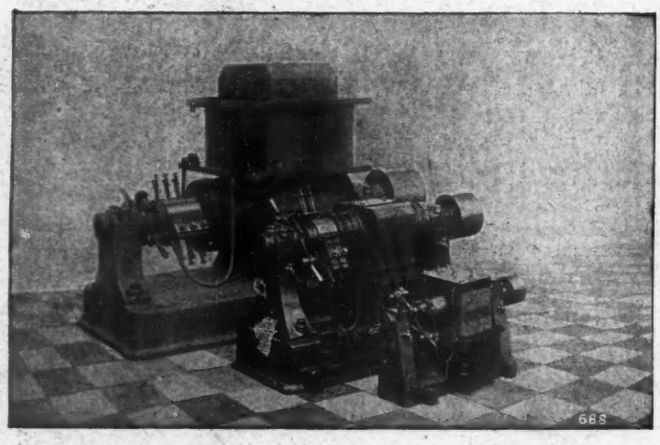

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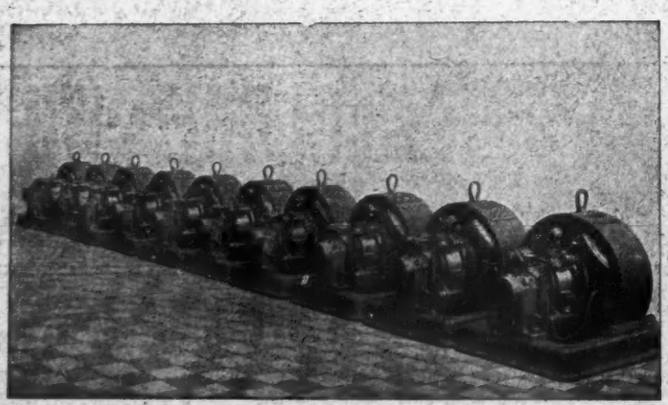

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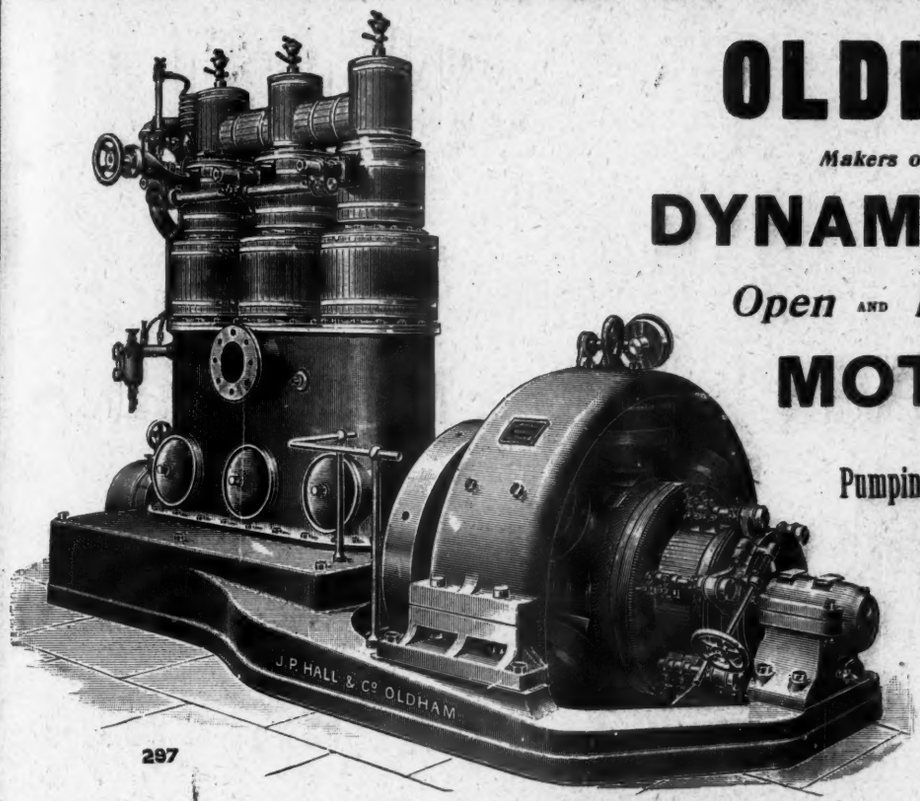

FIG. 203.—STANDARD MULTIPOLAR GENERATOR.

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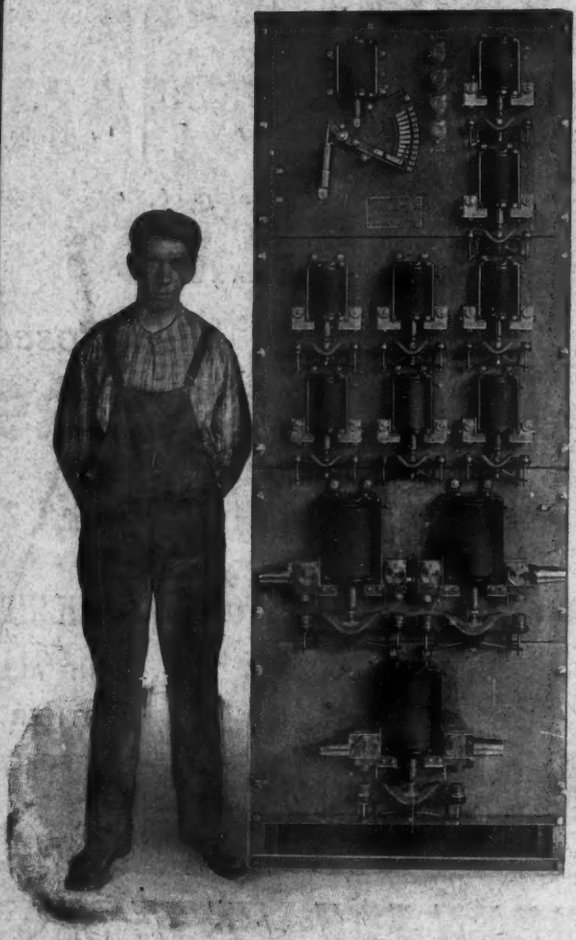

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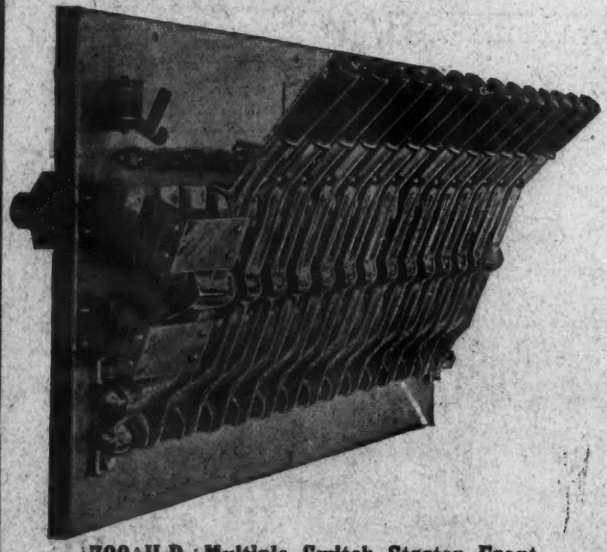

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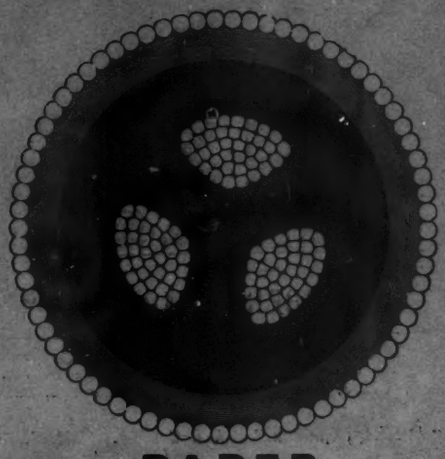
T  T

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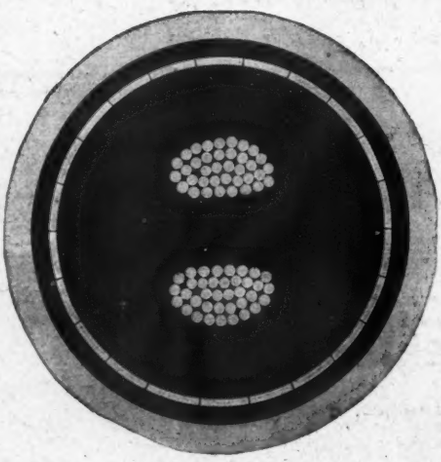

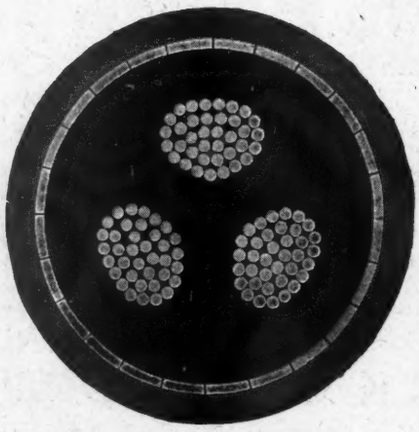

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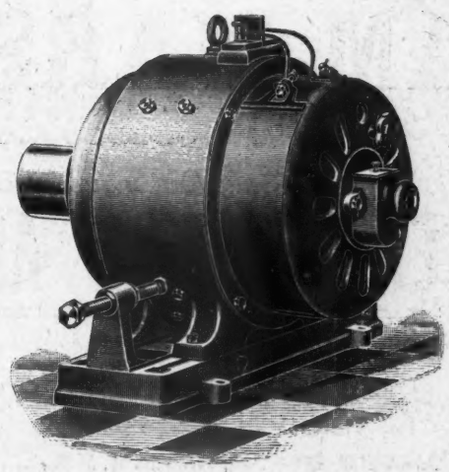

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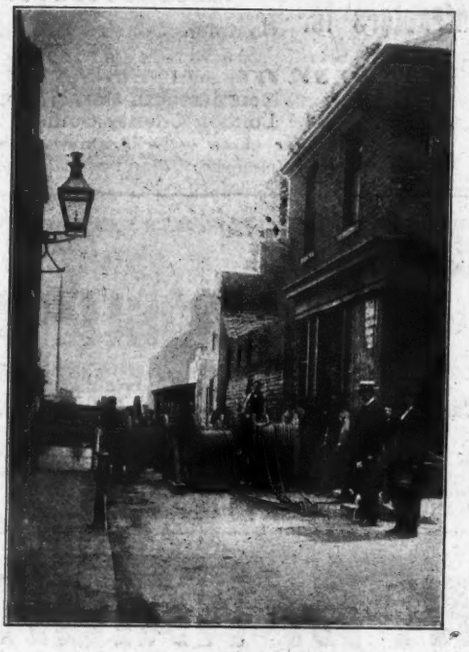

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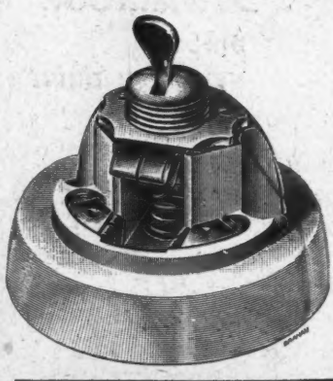

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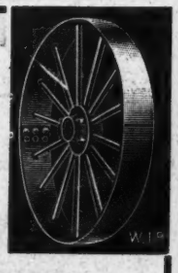

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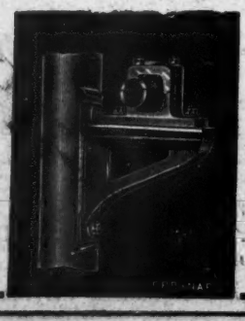

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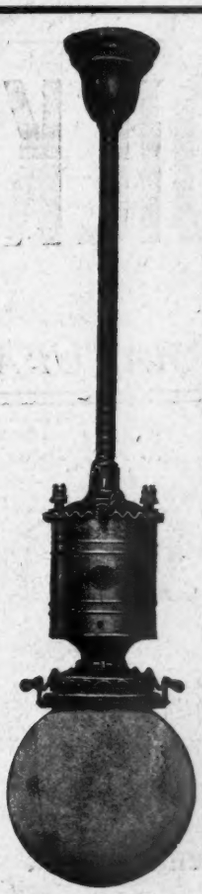

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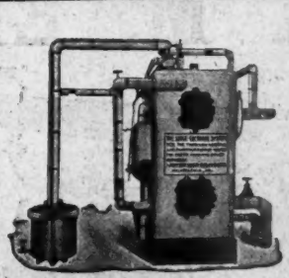

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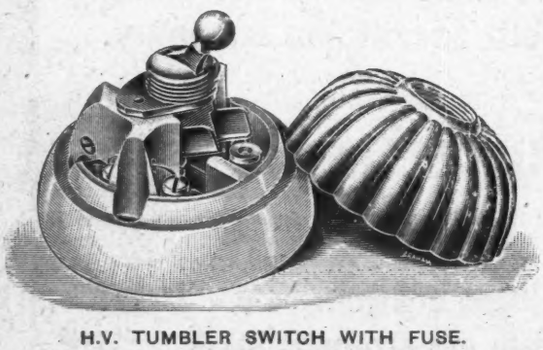

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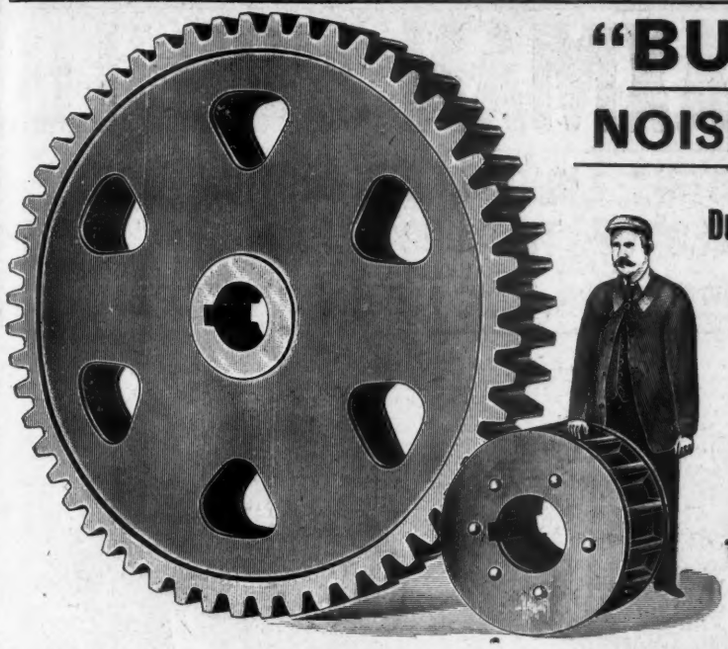

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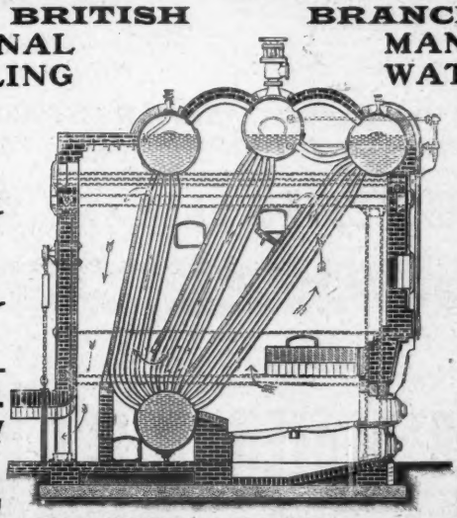

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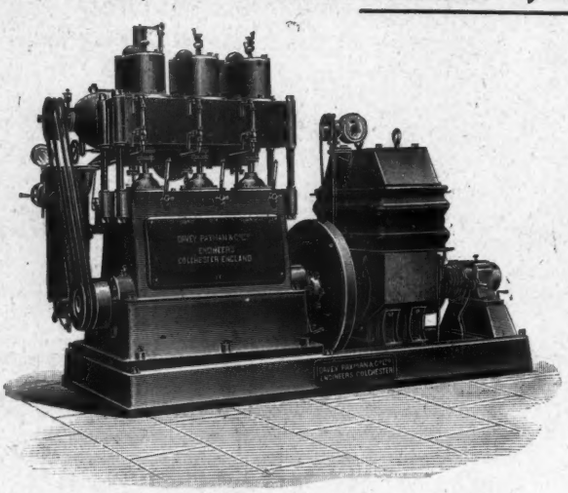

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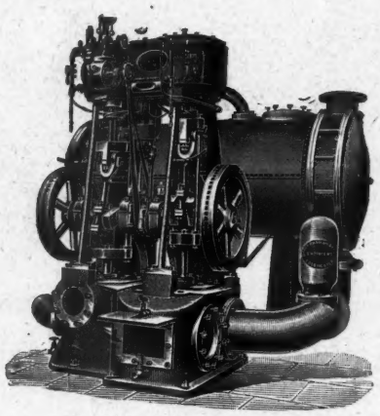

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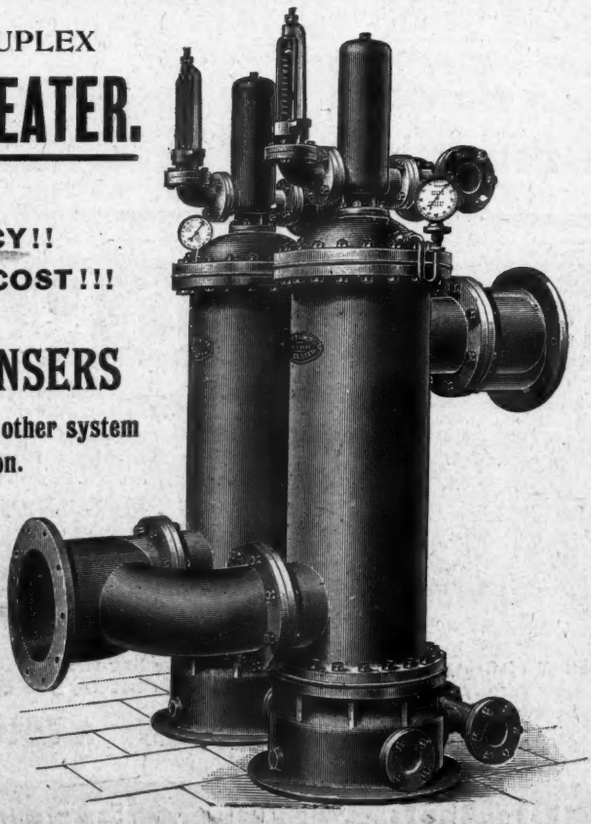

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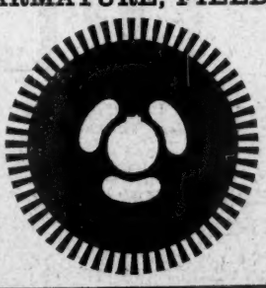

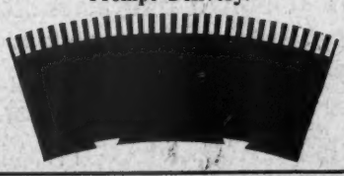

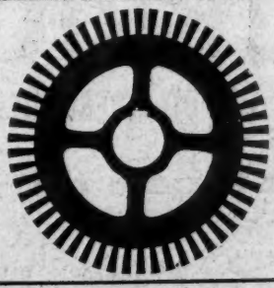

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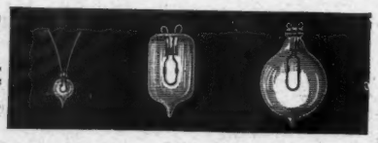

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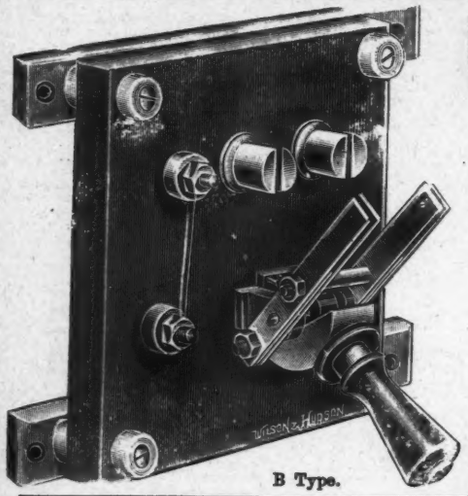

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(Continued on Next Page.)

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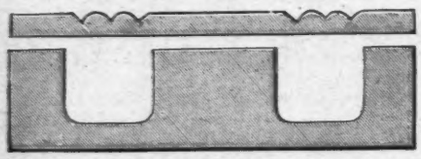

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2 "	1¾ "	4/4	42/-
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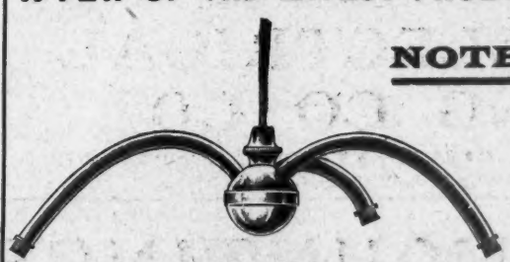

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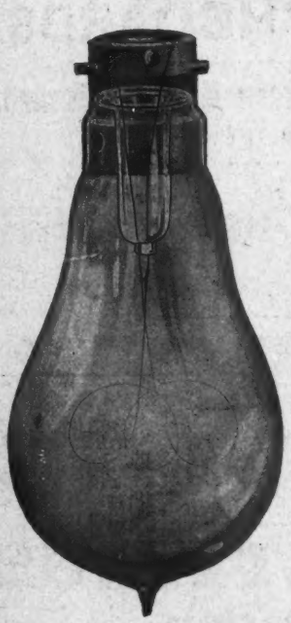

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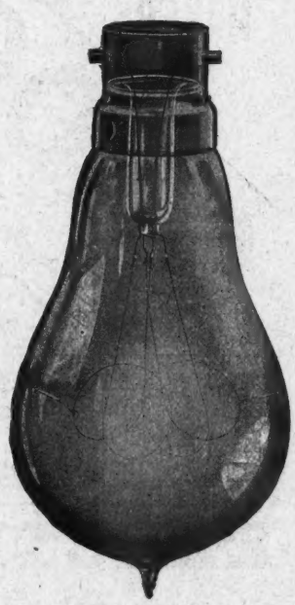

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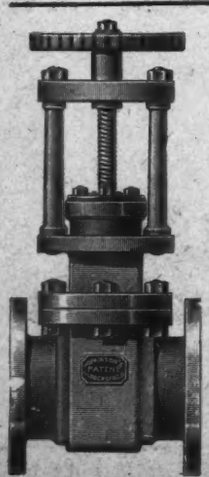

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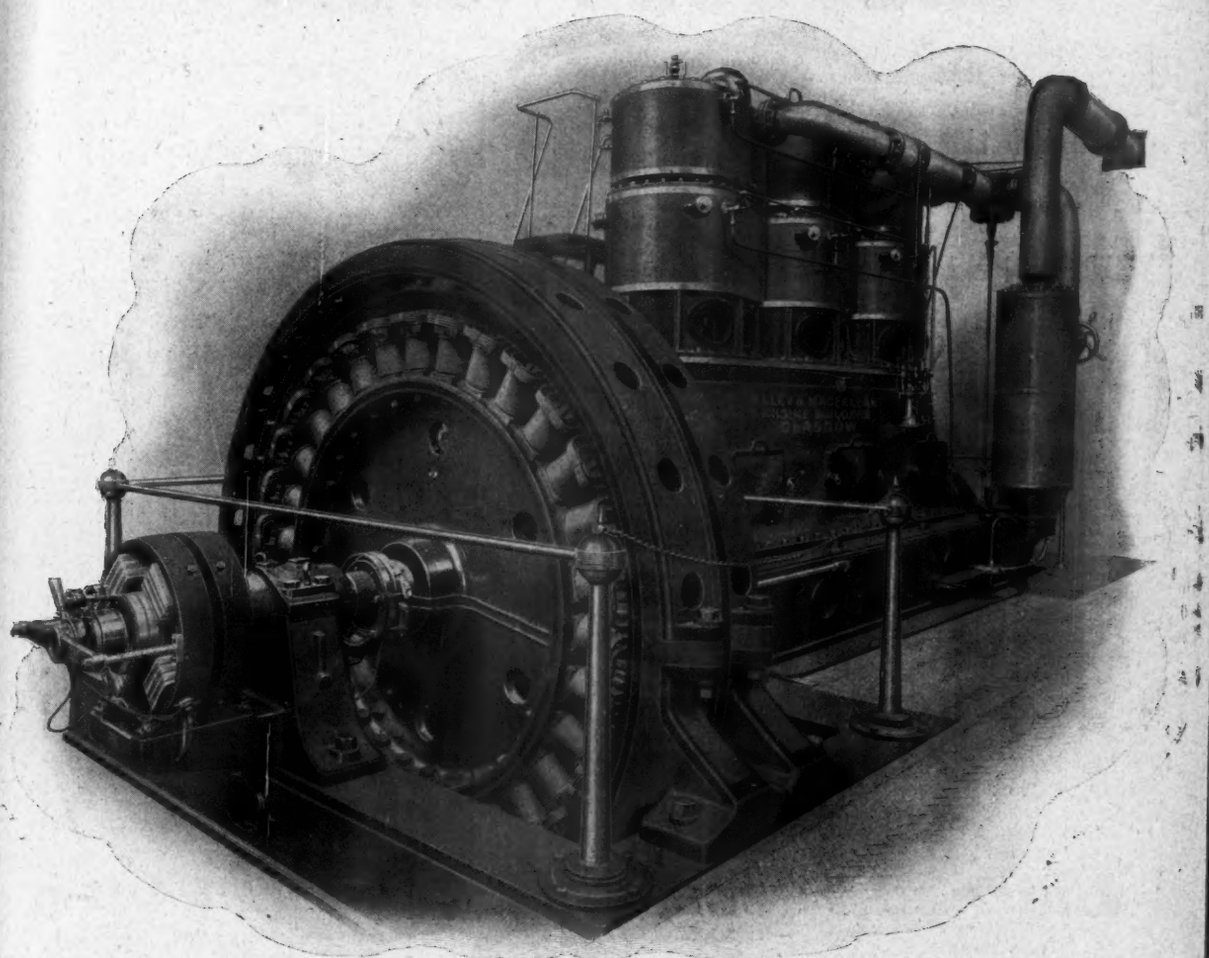

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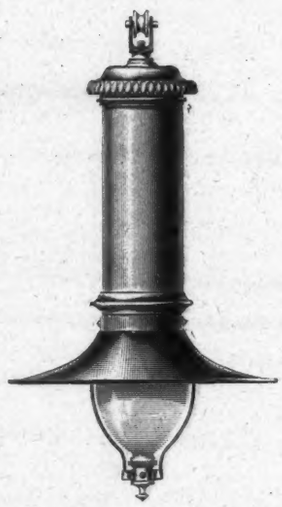

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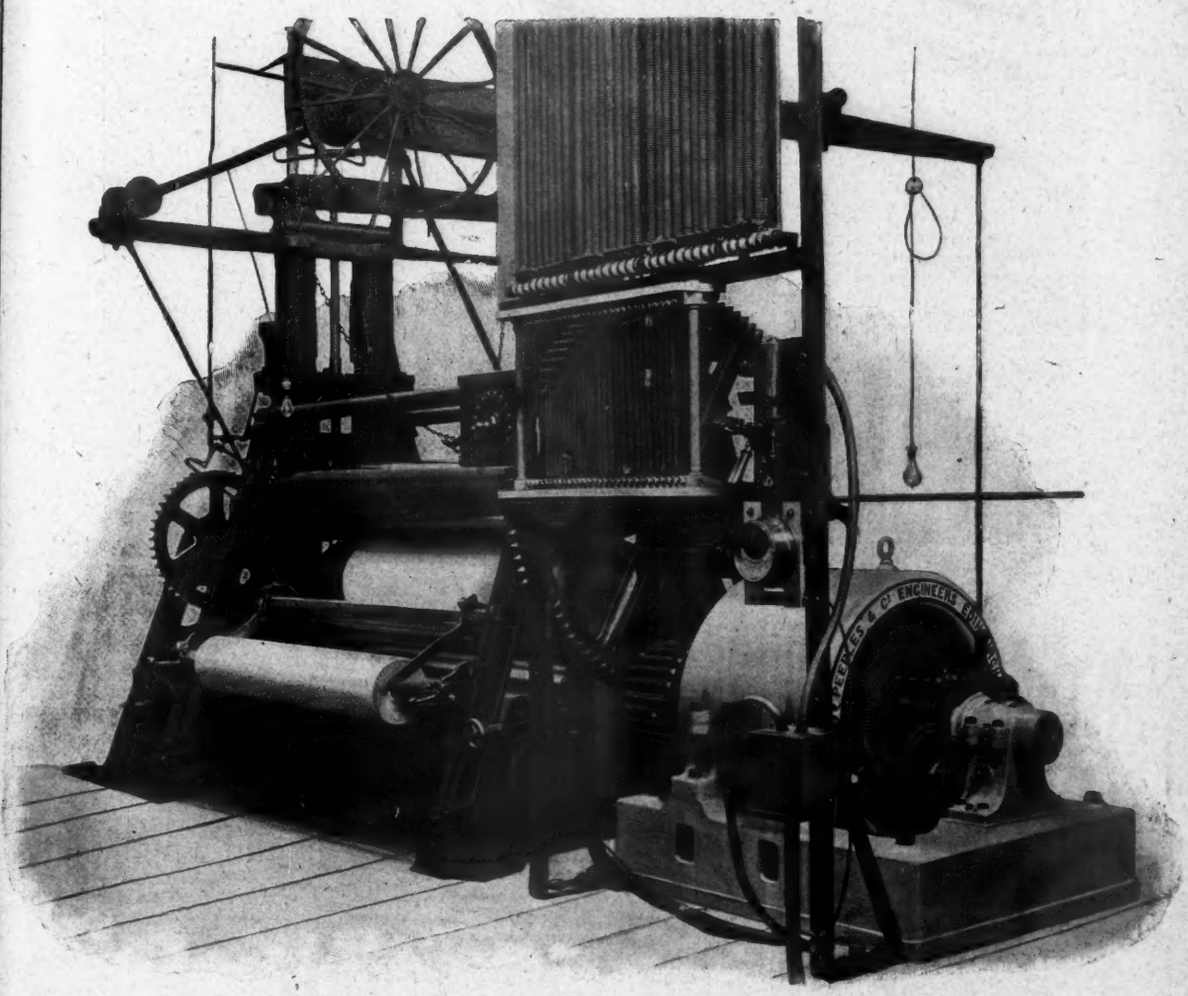

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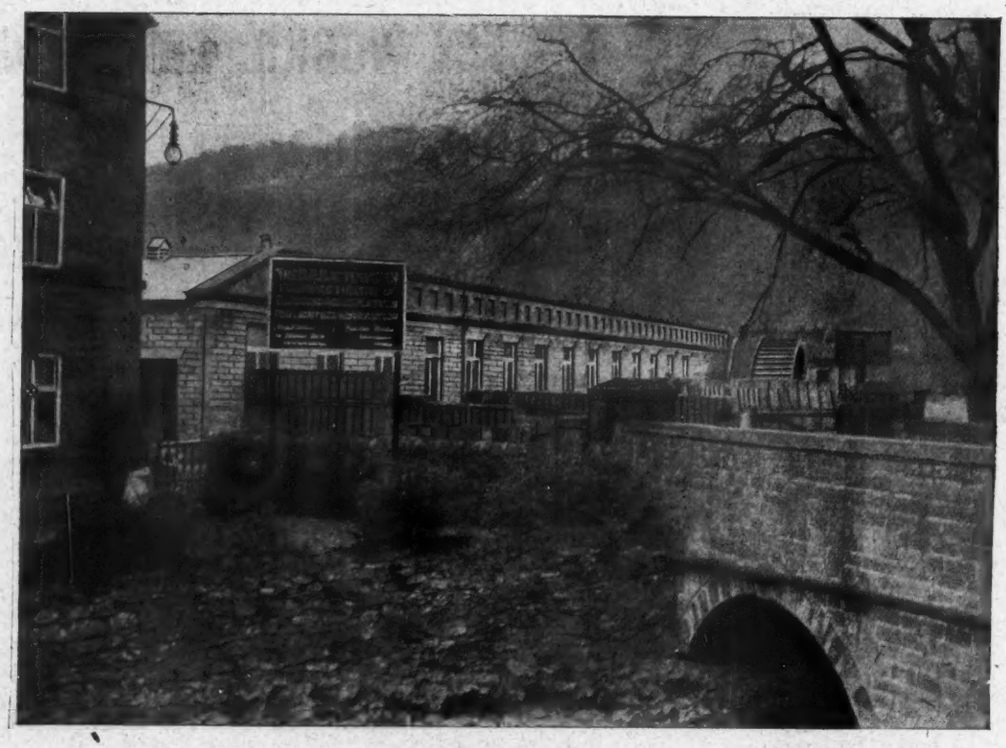

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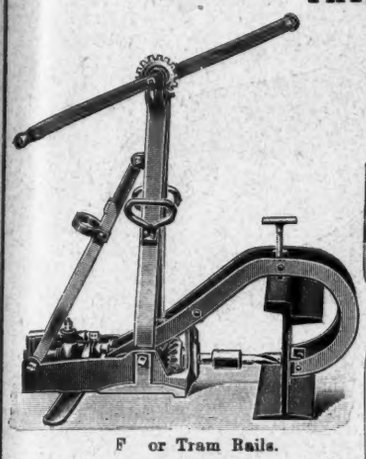

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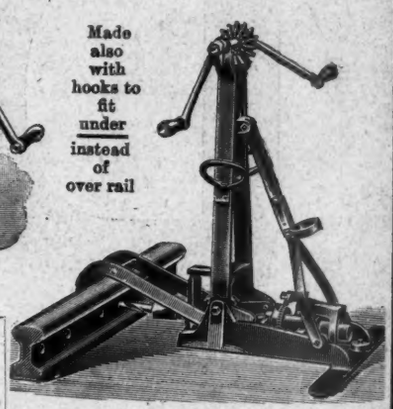

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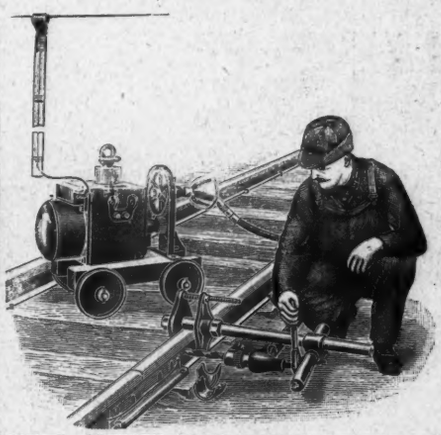

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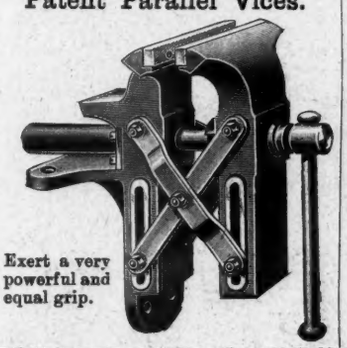

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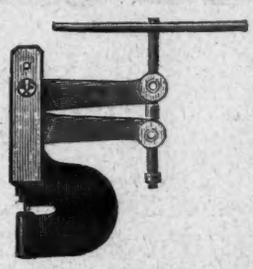

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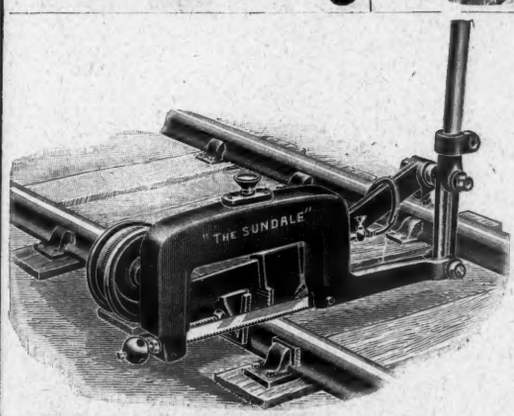

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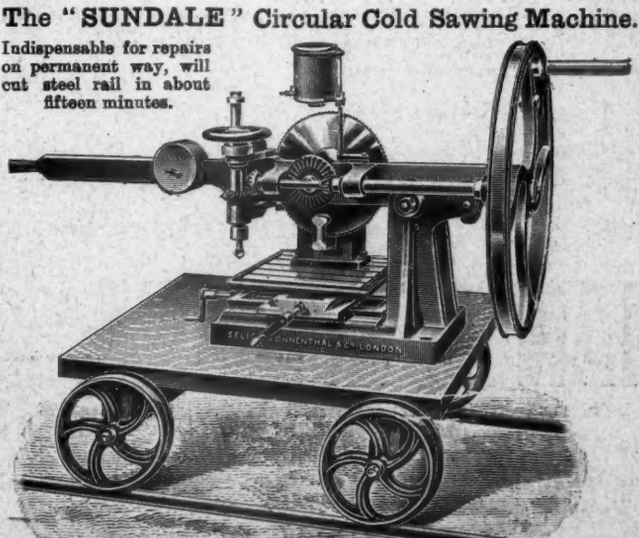

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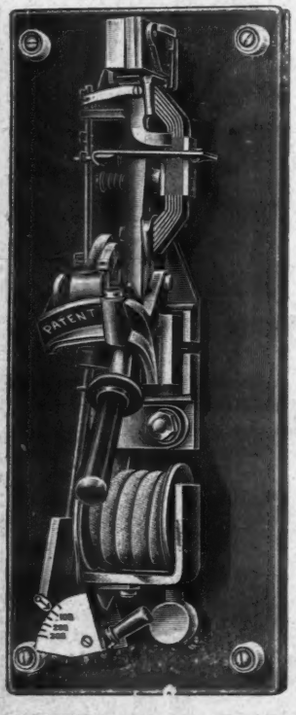

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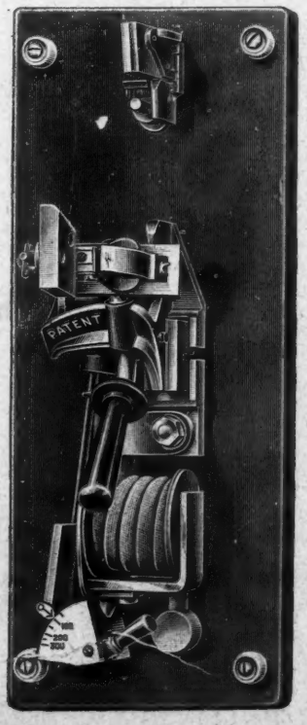

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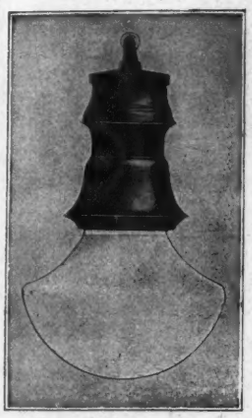

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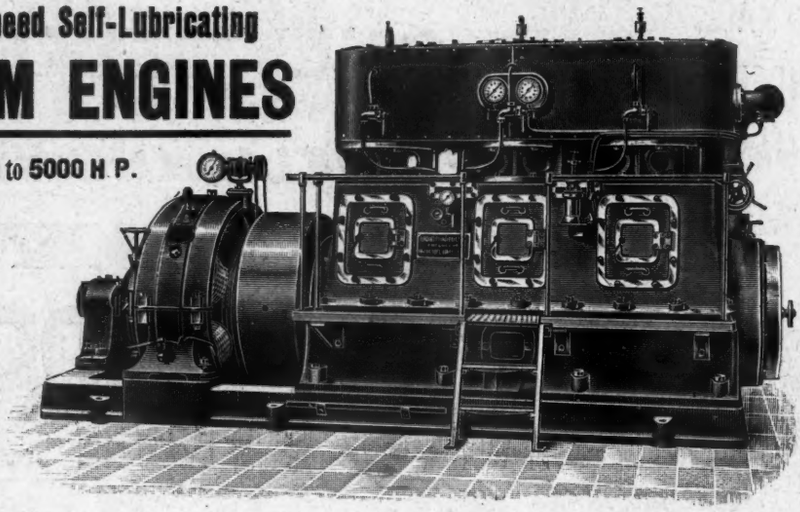

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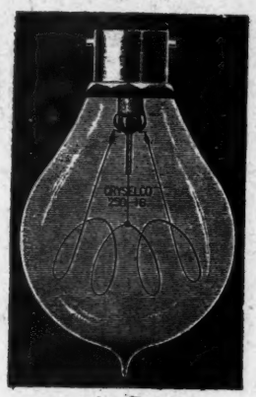

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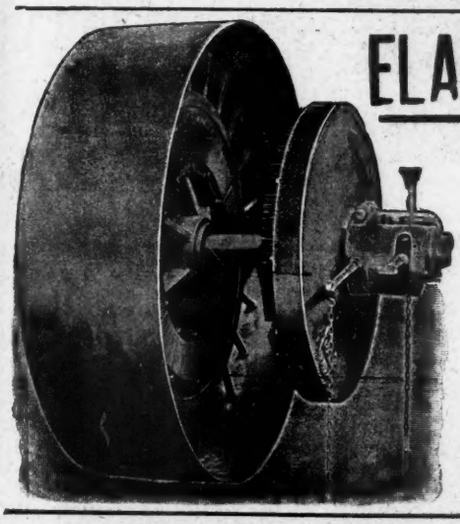

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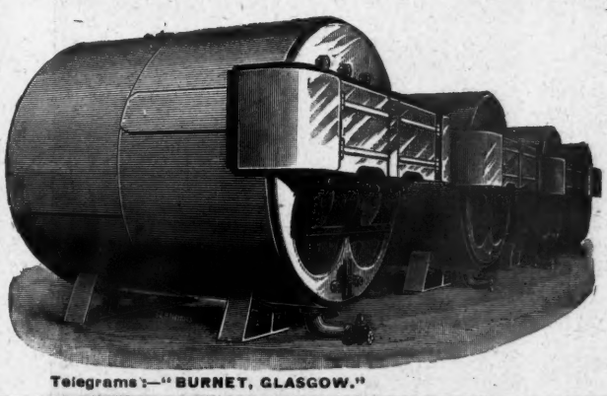

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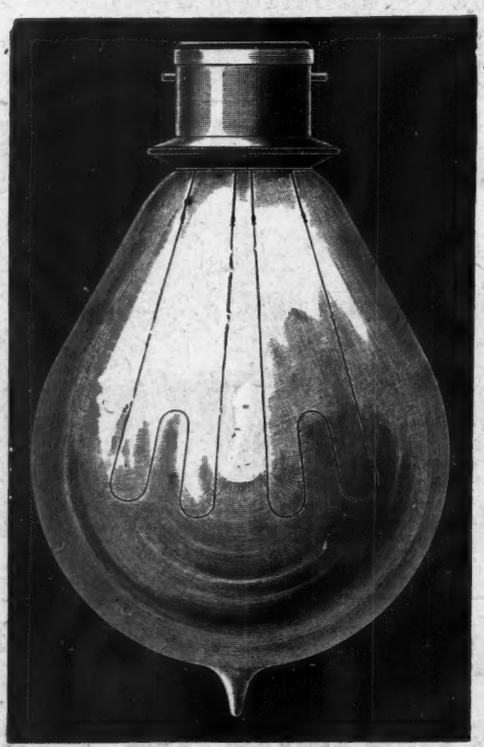

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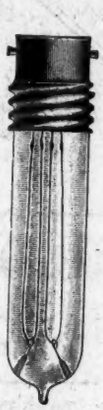

FIG. 1.

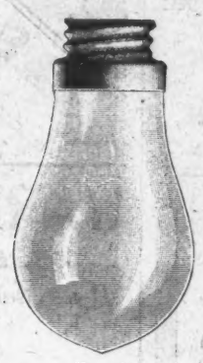

FIG. 2.

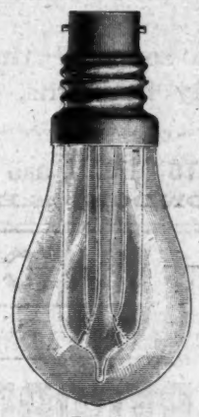

FIG. 3.

being screw-threaded. Fig. 2 shows a red-coloured glass bulb of the usual form, the open end of which is fitted with a screw-threaded piece, by means of which it can be quickly fixed over the white lamp, as shown in fig. 3. Thus the new lamp can fulfil all the functions of the usual two lamps, as, when a white light is required, all that need be done is to remove the outer red bulb. There is, also, the additional advantage that, when the lamp requires renewal, it is only necessary to purchase an ordinary white one of cylindrical form. The lamps are made with both screw and bayonet methods of socket attachments and for various voltages and candle-powers.

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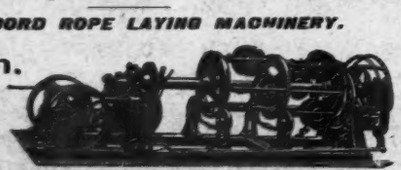

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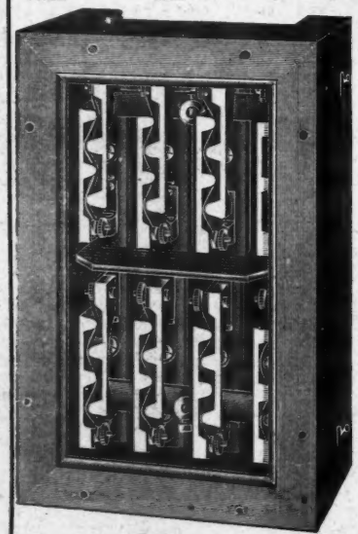

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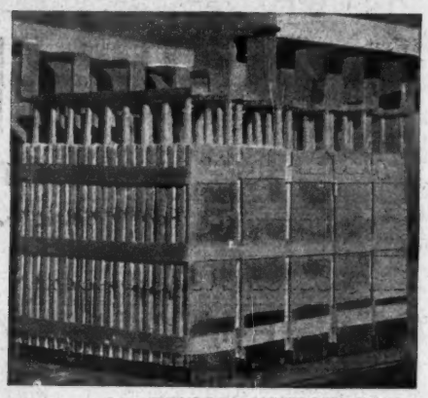

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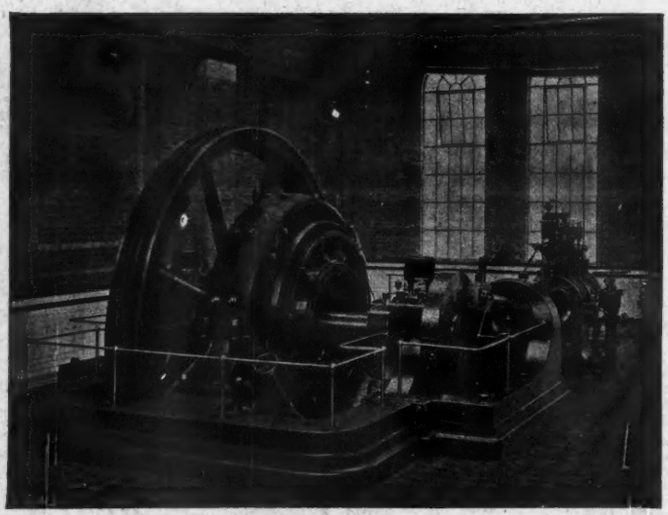

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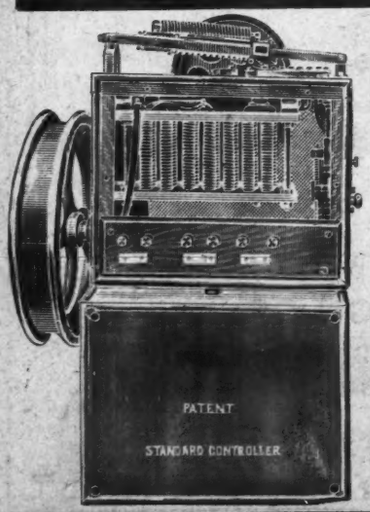

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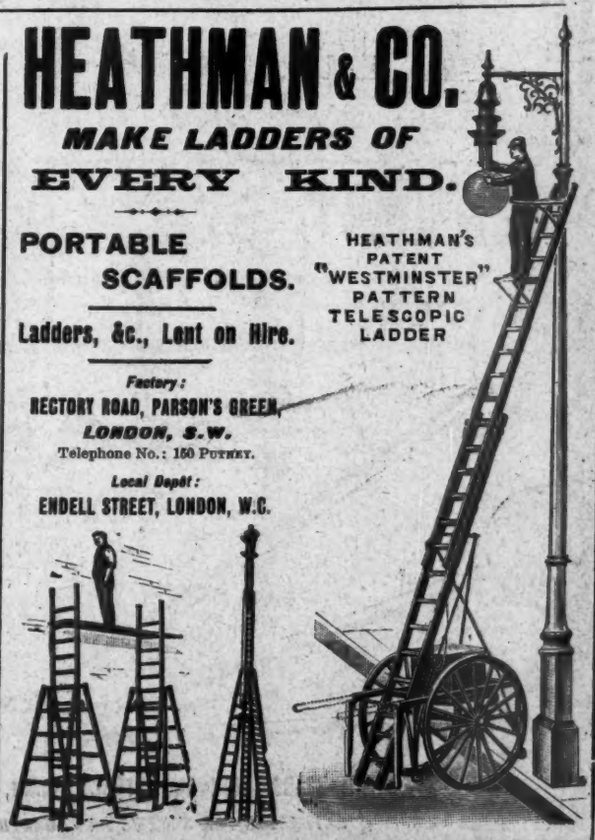

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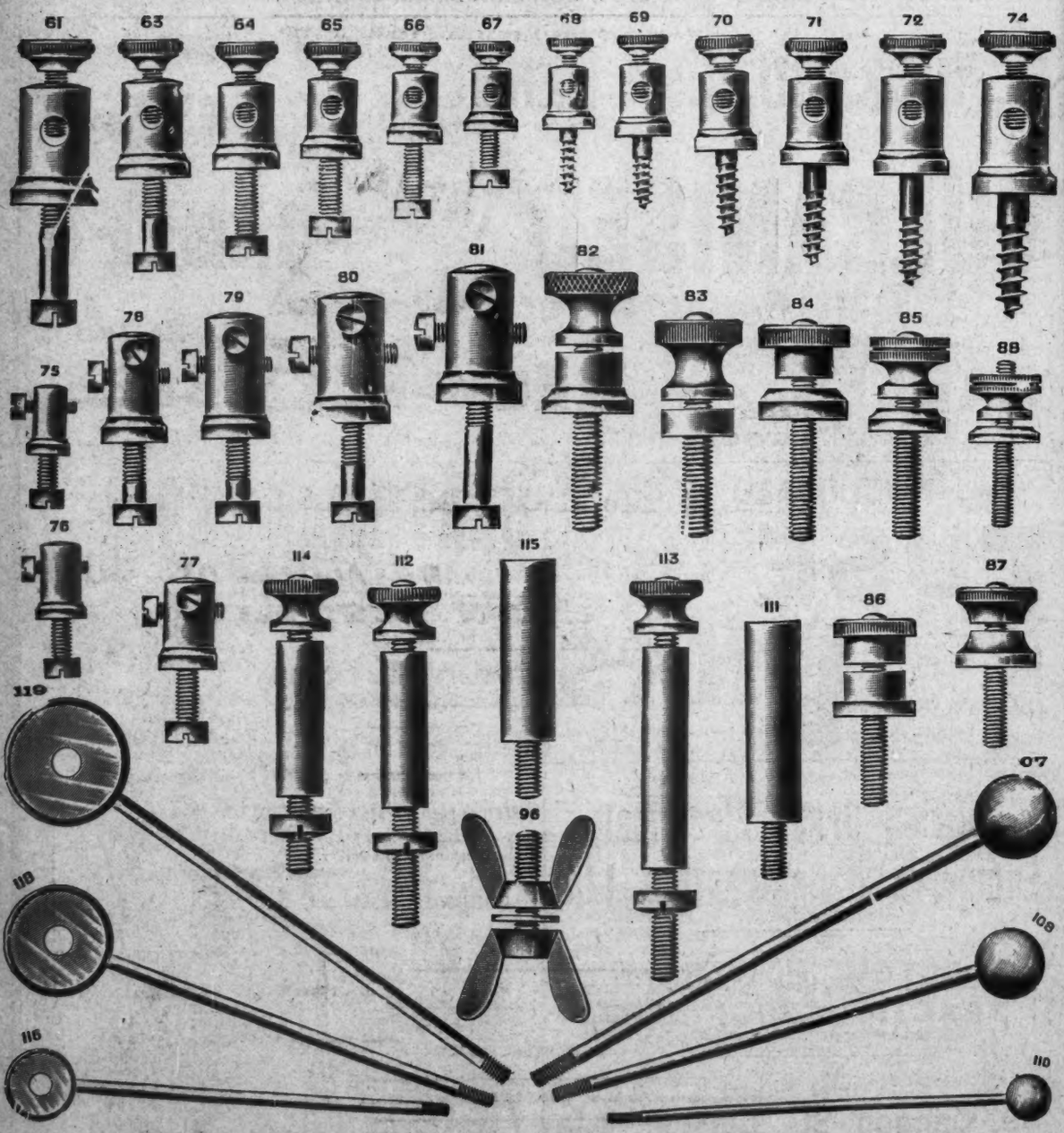

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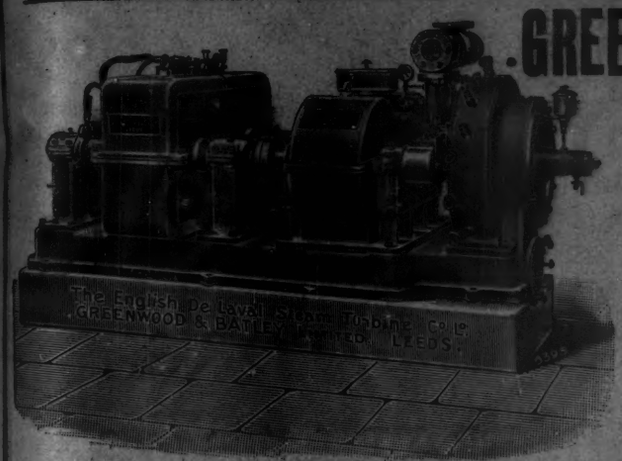

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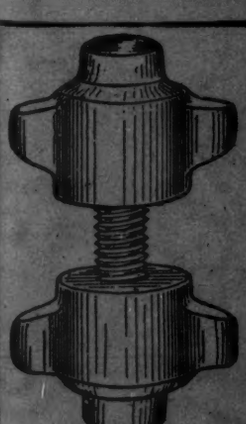

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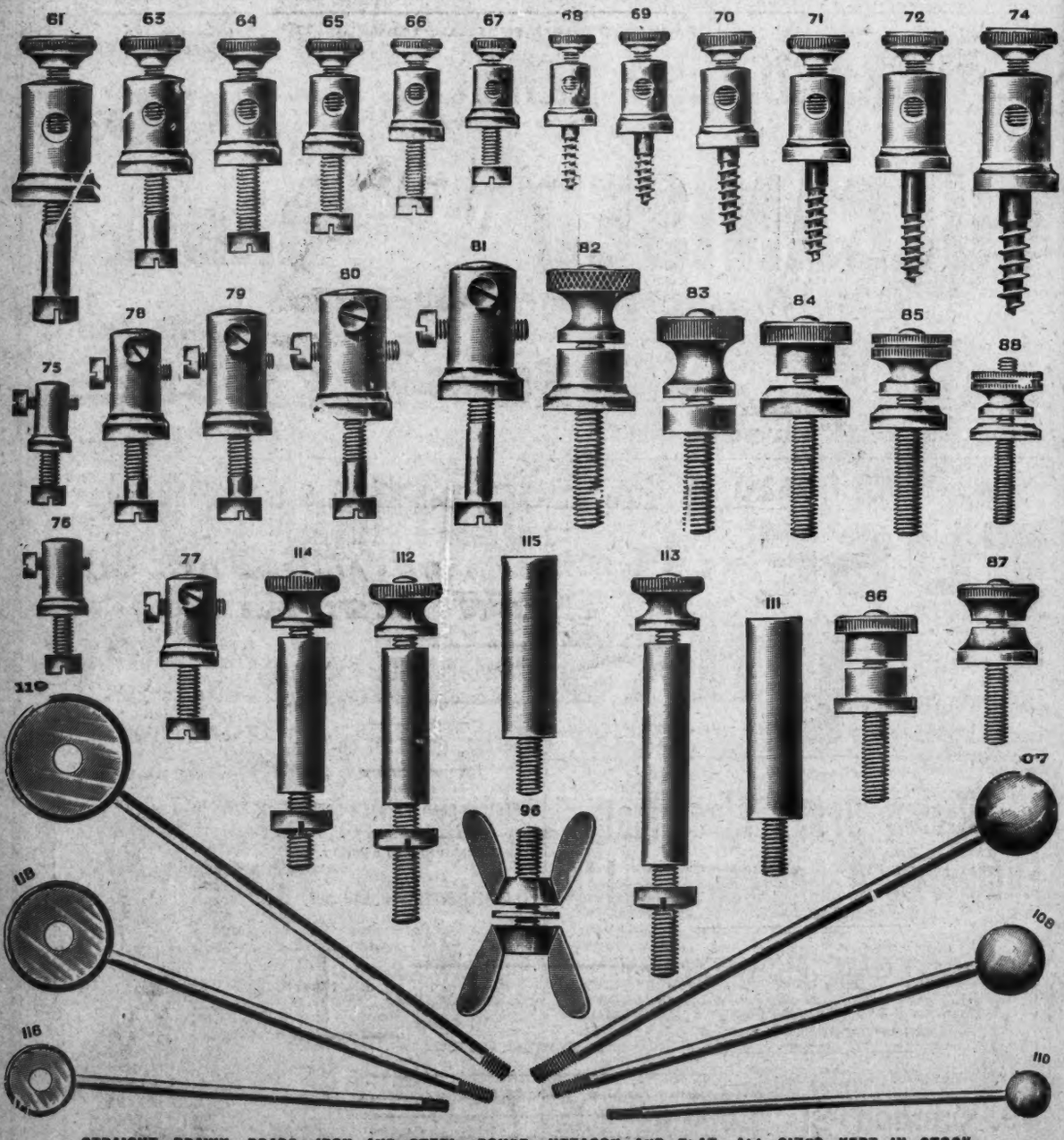

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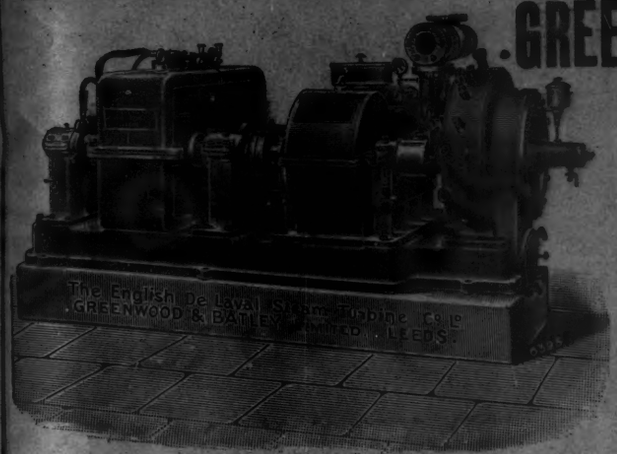

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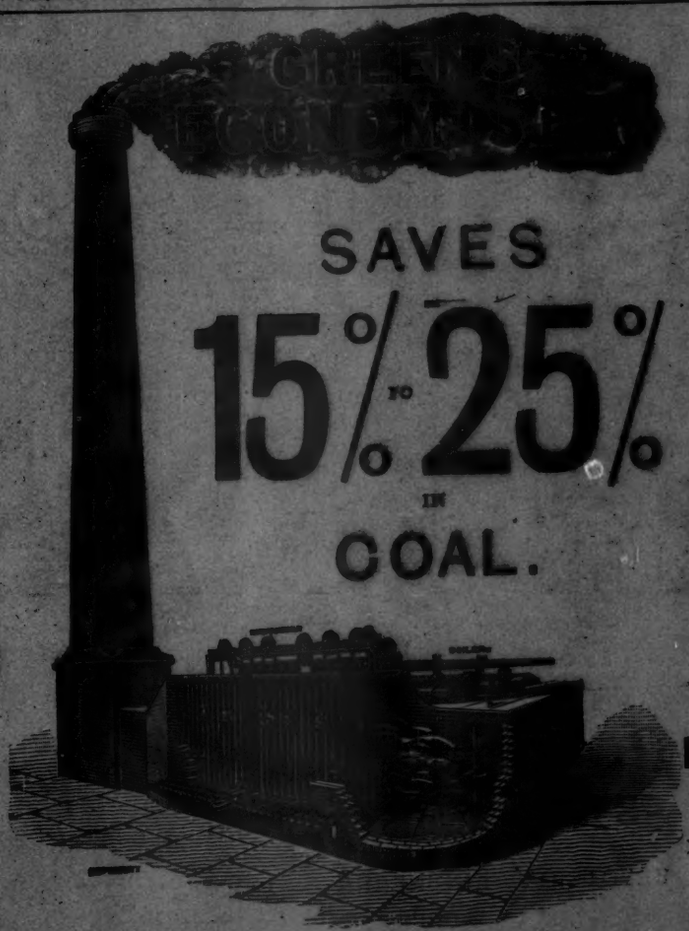

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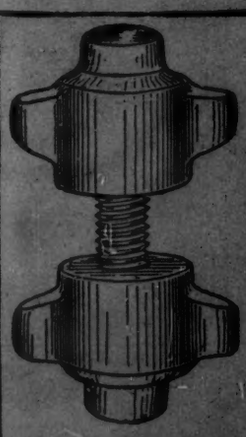

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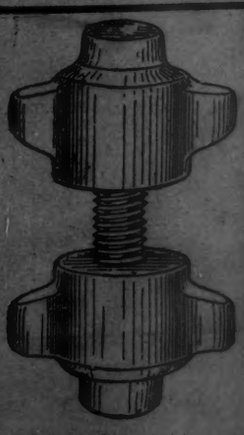

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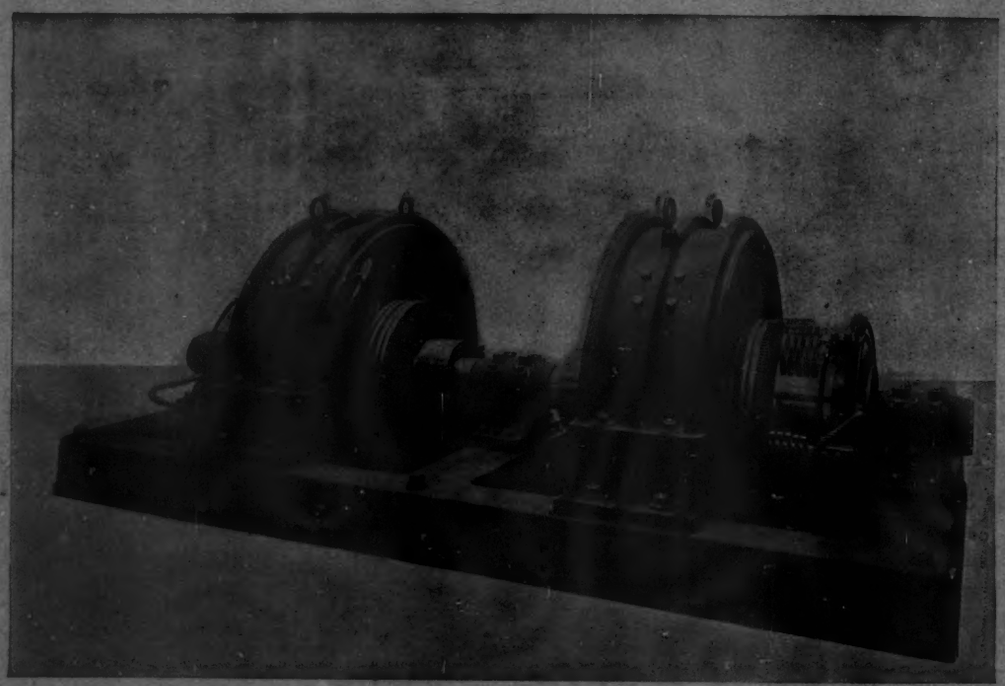

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